TECHNICAL BULLETIN

T-021

INSTALLATION OF ONAN MARINE GENERATING PLANTS

FEBRUARY 1970

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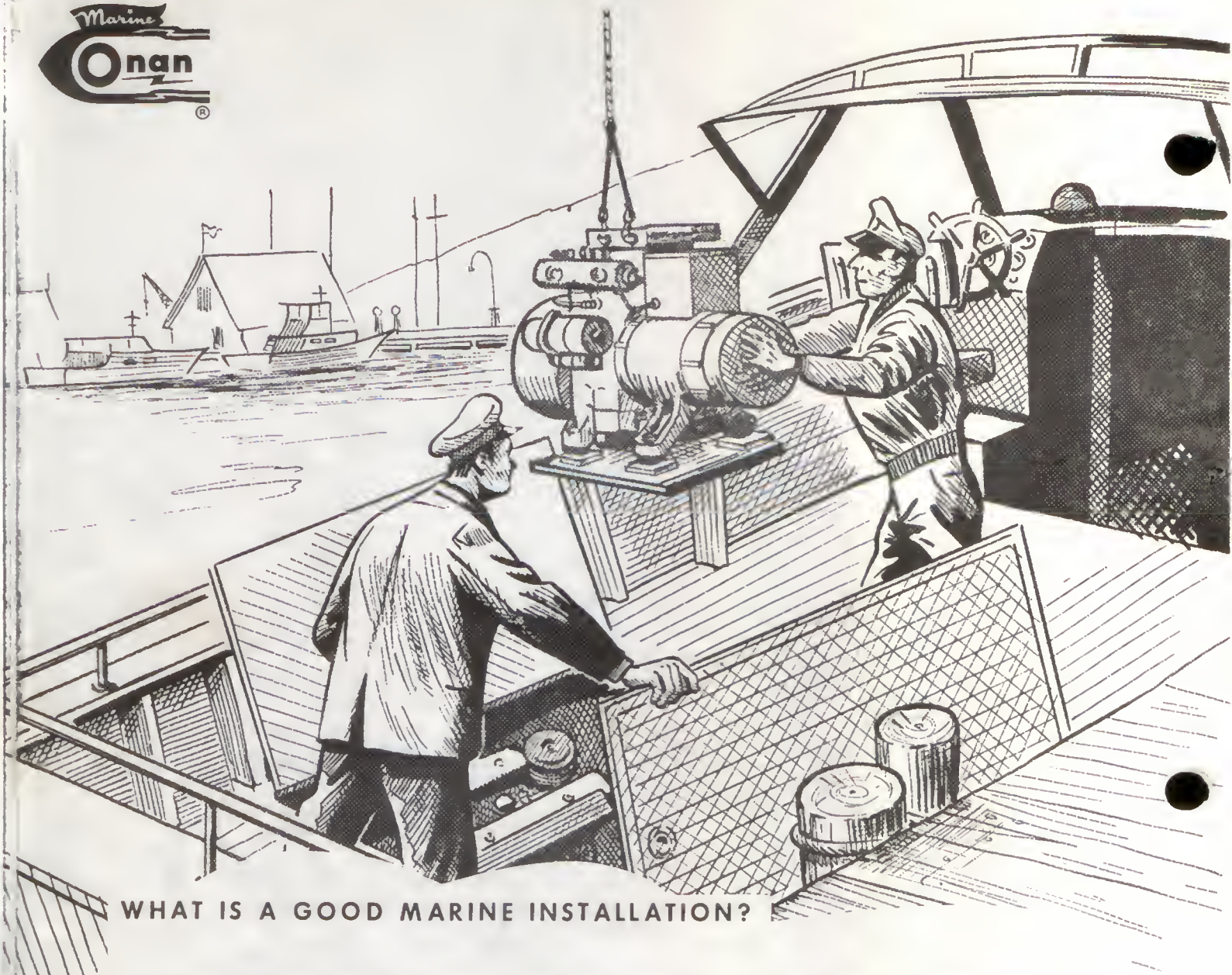

WHAT IS A GOOD MARINE INSTALLATION?

A boat owner considers the marine electric plant well installed if it supplies electricity quietly, reliably and efficiently.

But, how do you as the installer tell a good installation? Look for these characteristics! The plant should be mounted on its vibration isolators and the isolators firmly mounted to a strong base. Exhaust, water and electrical lines should be mounted to the boat and connected to the plant through a flexible section. The plant is properly mounted only if you can shake it back and forth easily without hitting anything. Look for an exhaust system that is cooled with water as much as possible and still protects the plant against water backwash. Whatever cooling system used, it should be planned for simplicity and free of restrictions to water flow. A good installation has electrical wiring which meets all applicable codes and has a well ventilated generator compartment so the plant receives clean air and runs cool.

Finally, the installation must be safe. The Coast Guard and National Fire Protection Association have set up standards of safety and we've tried to repeat them for you in this bulletin. These are a must.

So, it boils down to three steps, good planning, good workmanship and following the established requirements. We furnished this bulletin as a guide to the requirements and planning methods. The good workmanship will be yours.

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SCOPE

If your marine electric plant is to operate properly, it must be installed properly. This technical bulletin describes and details all the facets of current proper installation requirements for Onan marine electric plants and their associated controls. The requirements herein are based on the fire protection standards of the National Fire Protection Association (NFPA), regulations of the United States Coast Guard and the standards of the American Boat and Yacht Council (ABYC). These recommendations are based on the knowledge and experience of Onan engineers, servicemen and distributors.

Though this bulletin refers specifically only to electric plants up to 15 kw, the information can be adapted to plants of any size.

Because of the wide variety of boats in use today and the resulting diversity of installations, it is not possible to give instructions for any one installation. At times the information becomes quite general, but can be adapted to your particular installation.

This bulletin doesn't cover installation of electrical load distribution systems, or any subjects dealing with boat wiring.

MOUNTING

Onan marine electric plants are supplied with vibration isolator mounts and on some models, drip pan. A mounting base must be prepared to mount the plant to engine stringers or other strong supports in the boat. Vibration isolators are shown in Figure 1.

When preparing the electric plant mounting base, consider these requirements:

The base must be strong enough to support and secure a weight of several hundred pounds, even in heavy seas. A firm mounting base not only secures the electric plant, but prevents transmission of engine noise to the boat frame. Use a minimum thickness of 1″ plywood with 2″ x 6″ supports.

ELECTRIC PLANT LOCATION & MOUNTING

LOCATION

Several factors must be considered when selecting the location for an electric plant. It is usually best to have it in the same compartment as the main engines. Engine compartments are ready-made for the electric plant; they are ventilated, insulated, and usually the center of the electrical load.

In any case, the electric plant should be separated from

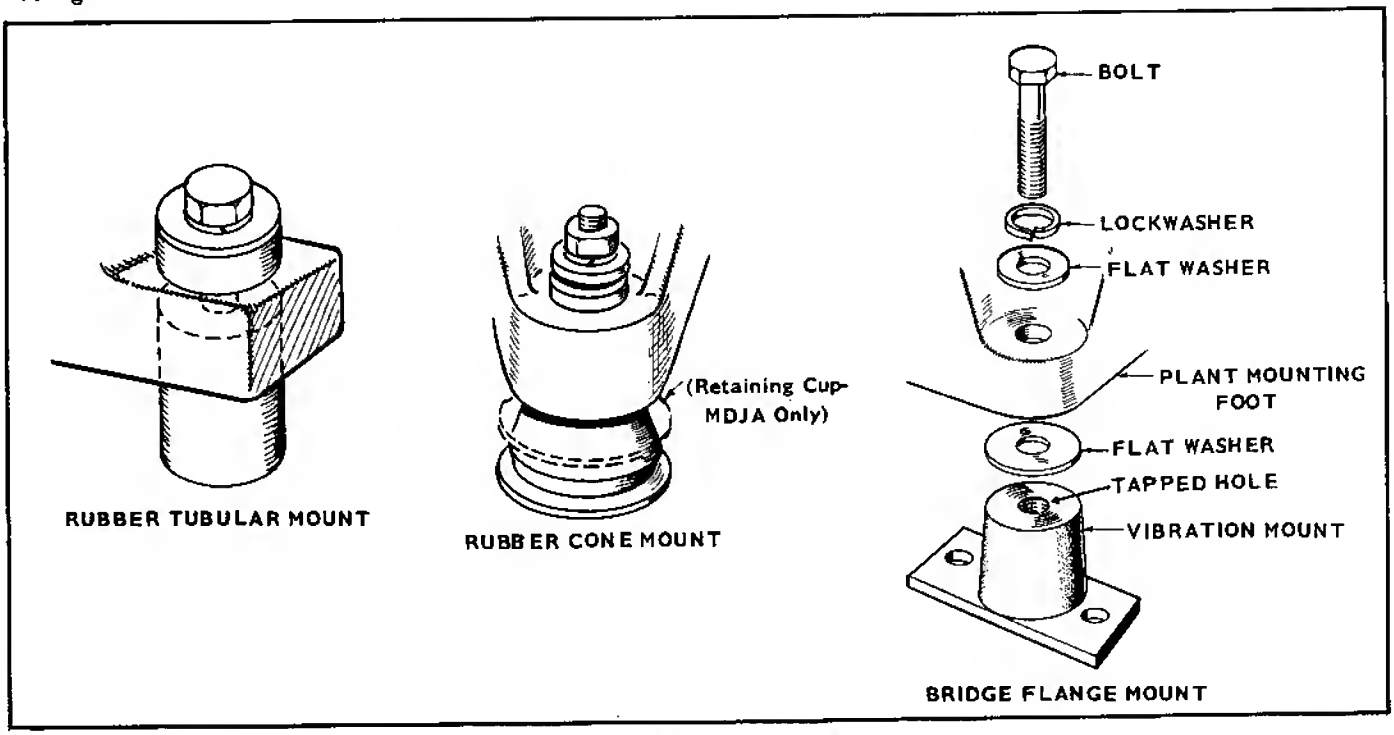


FIGURE 1. VIBRATION ISOLATORS

the living quarters. Keep the plant above and away from bilge splash and low lying vapors. When installed, it should be accessible for minor servicing and even for major servicing such as cylinder head removal. Investigate the boat and locate the plate wherever these and any other special considerations are satisfied.

Consider also fuel, water and exhaust connections. For more information about these, see their respective sections.

Space MUST BE LEFT ON ALL SIDES of the electric plant to allow for rocking on the rubber vibration mounts during operation. The plant requires at least 2-1/2" clearance on all sides.

With these points in mind, the base can be either metal or wood, but must be strong enough to prevent transmission of electric plant vibration to the hull. The plant vibration isolators cannot perform efficiently unless the mounting base is vibration free.

Wood mounting bases can be made of plywood or timbers. Figure 2 shows a base made of 1" plywood mounted on the engine stringers. Boats with metal structural members often use a metal mounting base. When building a mounting base for electric plants equipped with a drip pan, be sure the base gives a support to the plant mounting points, the complete drip pan, and the hold-down clamps. To prevent transmission of vibration, the mounting base should not touch any part of the bulkheads or freeboards.

Engine stringers normally are the best support in the boat for a mounting base. Other equivalent size stringers can be used, but be cautious about using hull frames; often they are not strong enough to prevent transmission of generator noise to the hull.

With the mounting base built and in place, the vibration isolators or drip pan can be installed on it. Onan marine electric plants currently employ three different types of vibration isolators (Figure 1). Isolators mount directly on the base, or to the drip pan, if furnished. Install rubber cone mounts on the plant drip pan spacer plates. When installing rubber cone mounts, use the bushing supplied with the mounting kit to prevent excessive rubber cushion compression. Be sure to install the rubber cushions in the correct position on the plant with the highest part number under the generator end, as marked on each cushion.

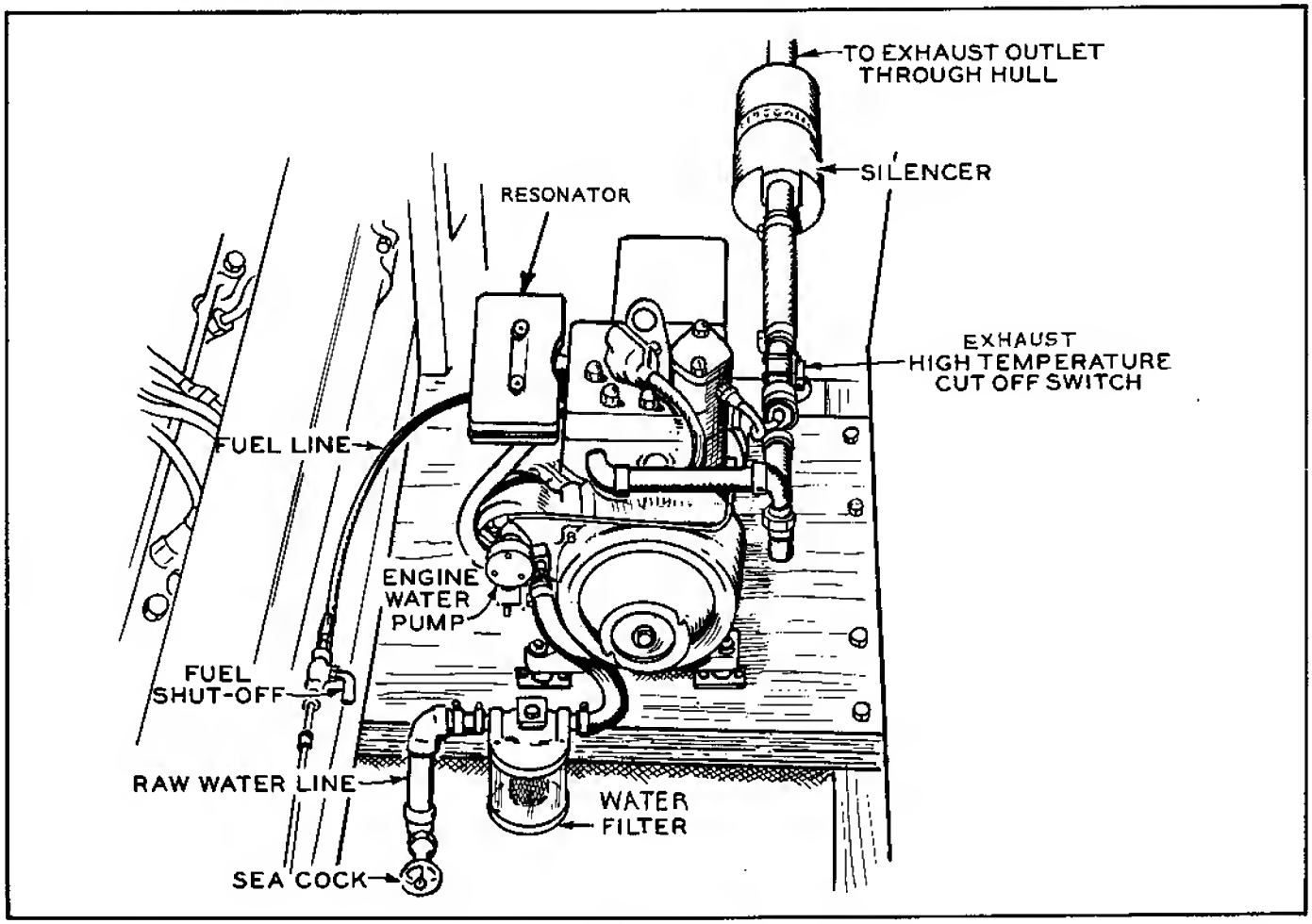


FIGURE 2. TYPICAL MAJ ELECTRIC PLANT

VENTILATION

Electric plants must have free air circulation while operating to remove any possible accumulation of inflammable gases. Provide combustion air for the engine, and cooling air for the generator.

Table 2 lists minimum air requirements in cubic feet per minute for Onan marine electric plants. In order to provide this air, generating plant compartments must have air inlets and outlets. If the fuel tank is in a separate compartment, it also must be ventilated. In addition to the above requirements, the ventilating system should meet the following Coast Guard and NFPA requirements.

COAST GUARD AND NFPA VENTILATING REQUIREMENTS

Both organizations require at least two inlet ducts and two outlet ducts for gasoline plant installations in a closed compartment, all ducts extending to the bilges. When the plant isn't located in a closed compartment, at least one duct should be installed in the fore section of the boat and another aft. The NFPA recommends the following vent size – at least two square inches of total aggregate inlet area and total outlet area per foot of boat beam. For boats the Coast Guard classifies as pleasure vessels, it requires that ventilation be sufficient to eliminate an accumulation of inflammable gases. For boats classified as passenger vessels under 65 feet long. The Coast Guard requires that ventilation be sufficient to change the compartment air within a given time interval (Table 1).

TABLE 1. PASSENGER VESSEL VENTILATION REQUIREMENTS

SIZE OF COMPARTMENT CU. FT.	MINUTES PER AIR CHANGE
Less than 500	2
500 to 1000	3
1000 to 1500	4
1500 and Up	5

For passenger vessels, the Coast Guard recommends a mechanical exhausting system to meet the requirement in Table 1. The exhaust blower motors should be outside the compartment for ventilation, and interlocked with the ignition switch so they operate when the ignition is on.

For diesel plant ventilation systems, the Coast Guard requires at least one inlet and one outlet, with the total inlet area not less than one square inch per foot of boat beam.

If a gasoline fuel tank is in a separate compartment, the compartment should be ventilated according to the same requirements as the engine compartment. A separate diesel tank compartment should be ventilated with a single 2-1/2 inch gooseneck or other adequate ventilation. In a small compartment, a 1-1/2 inch gooseneck is sufficient.

Inlet ducts should have cowls or equivalent fittings with

TABLE 2. AIR REQUIREMENTS (CUBIC FEET PER MINUTE) OF ONAN MARINE ELECTRIC GENERATING PLANTS

PLANT	GENERATOR COOLING AIR 1800 rpm	COMBUSTION AIR 1800 rpm	TOTAL
0.6, 1.5MAJ (DC)	40	12	52
2.5MAJ *	60	16	76
3.0MDJA	75	16	91
6.0MDJB, 7.5MDJE	135	32	167
12.0MDJC, 15.0MDJF	125	62	187
10.0, 15.0MJC	126	64	190
4.0, 6.5MCCK	75	21	96

* - This plant operates at 3600 RPM for 60 cycle rated output.

twice the area of the duct and larger if the mouth is screened.

Don't use recessed or flushed inlets or louvered transom outlets.

ELECTRIC PLANT VENTILATION

In most cases, boat manufacturers install engine compartment ventilating systems that comply with the above mentioned Coast Guard and NFPA requirements. This will facilitate generating plant installation, but be careful of the following points.

In addition to clearing the compartment, ventilating air cools the generator. The compartment ventilation must be sufficient to prevent recirculation of generator cooling air. On boats equipped with a mechanical ventilating system (exhaust blowers), the blowers usually provide sufficient fresh air. If the engine compartment is ventilated by boat or wind motion and is without power exhausters, ventilation is seriously reduced when the boat stops; at the same time the electric plant is often run at heaviest load.

The best solution is to use power exhausters in all installations, one blower in each exhaust duct. Exhausters should have a total air capacity, in cubic feet per minute, of 1-1/2 to 2 times the electric plant total air requirements shown in Table 1. Establishing the correct air flow quantity is especially important in small compartments (under 1000 cubic feet). Normally, ventilation systems that meet the Coast Guard ventilation requirements for gasoline engines in passenger vessels (Table 1) will supply sufficient cooling air for the electric plant under all conditions.

Any power blowers in the engine or electric plant compartments should be wired to operate whenever machinery in the compartment is running. Blowers can be wired to operate automatically whenever the electric plant is running by wiring them to the plant output or control, or they can be operated by a separate switch located at the pilot's station or another convenient location.

EXHAUST SYSTEM

All exhaust systems for water-cooled marine installations must meet these requirements:

Except for vertical dry stack systems, exhaust systems must be water cooled, the water to be injected as near to the plant as possible.

All exhaust system sections before the point of cooling water injection must be either water jacketed or effectively insulated.

The exhaust line must be installed so as to prevent back flow of water to the engine under any conditions, and the exhaust outlet must be above the load waterline. Any water flowing back to the engine will damage it.

The exhaust system must not be combined with the exhaust system of any other engine.

An approved, flexible, non-metallic exhaust line section should be used near the engine to allow for engine movement during operation.

Vertical dry stack exhaust systems must have spark arrestors. The exhaust system between engine manifold and spark arrestor must be either water jacketed or well insulated.

MATERIAL

Use exhaust line at least as large as the engine exhaust outlet (Table 3) but increase the entire line one pipe size for each 10 feet in length.

Either cast iron or wrought iron piping is recommended for exhaust lines. On gasoline installations, copper tubing is acceptacle, providing it is approved for marine installation (wall thickness greater than .083 in.). On diesel exhaust systems, copper tubing should be used only for the water cooled section of line. Most installations today use flexible rubber hose for the water cooled section of the exhaust line because of the ease of installation and flexibility. Be sure rubber hose used is designed for exhaust line use, such as heavy duty single braid reinforced rubber hose. Provide adequate support for rubber hose to prevent sagging, bending and formation of water pockets.

TABLE 3. ELECTRIC PLANT EXHAUST OUTLET SIZES

PLANT MODEL	EXHAUST OUTLET SIZE
MAJ	3/4"
MJDA, MDJB, MDJE	1-1/4"
MDJC, MJC, MDJF	1-1/2"
MCCK	1"

The flexible section of exhaust line should be installed between the engine and muffler (Figure 3). Do not connect the muffler directly to the exhaust manifold. Use rubber hose only in the water-cooled sections of the exhaust system. Do not install rubber hose with sharp bends as this will reduce efficiency and may cause eventual hose failure. Metallic flexible line is not recommended except in below water line or dry pipe installations. When using metallic flexible exhaust line, install in straight lengths only.

EXHAUST COOLING WATER INJECTION

Cool the exhaust with the full electric plant cooling system water output. If a keel cooler is used (no water output), install a separate hull water inlet and use the engine-mounted neoprene impeller pump to provide exhaust cooling water. When installing a separate system to cool the exhaust, a device is required to indicate if the water fails. Mount a temperature operated switch on the exhaust line and connect it to operate either an alarm or to shut off the electric plant if the exhaust overheats (approximately 200°F). Onan recommends high-temperature exhaust shutdown switches for all types of marine installations (Figure 4).

One of the most important considerations of water injection is to keep the water from flowing back through the exhaust system into the engine. The two most frequent causes of water entering the engine are:

1. Momentum built up by water sloshing in the exhaust line which causes the water to rush forward into the engine when the boat pitches forward. This is especially true in installations where there is a considerable length of straight exhaust line or where pockets allow water to gather. In most cases, you can't install the exhaust line with enough downward pitch to prevent it from tilting toward the electric plant when the boat pitches, so a baffle of some type must be included in

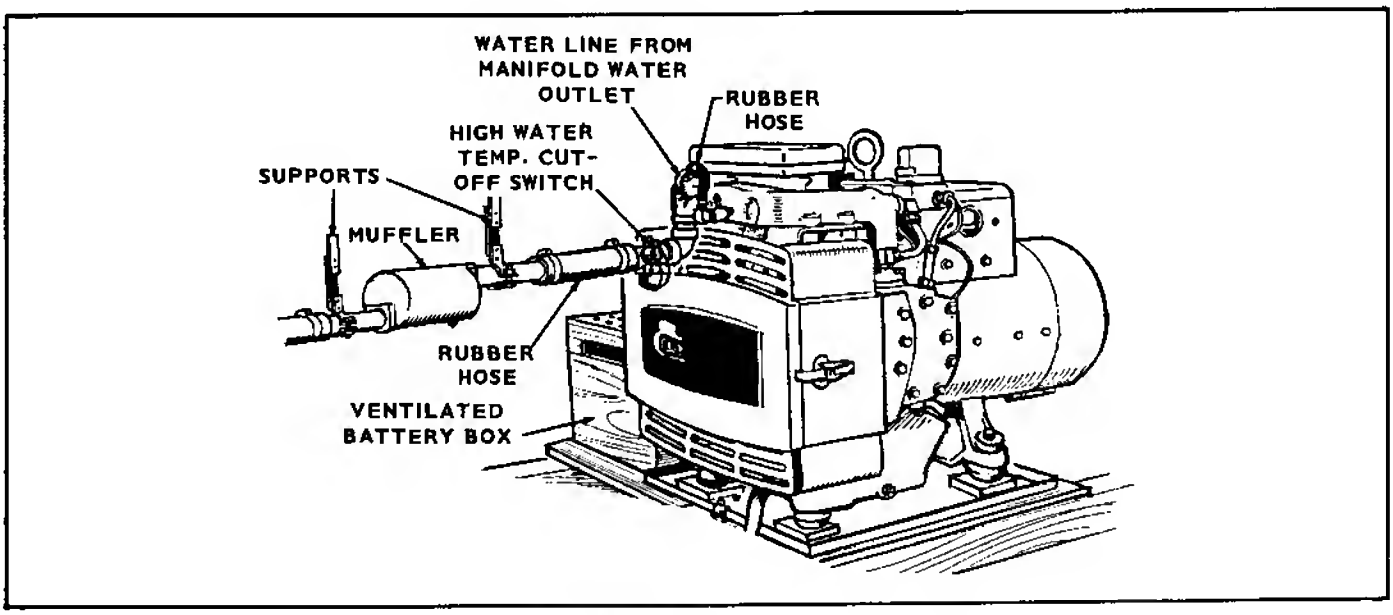


FIGURE 3. TYPICAL SMALL UNIT EXHAUST SYSTEM

the exhaust line to prevent water from pouring into the engine.

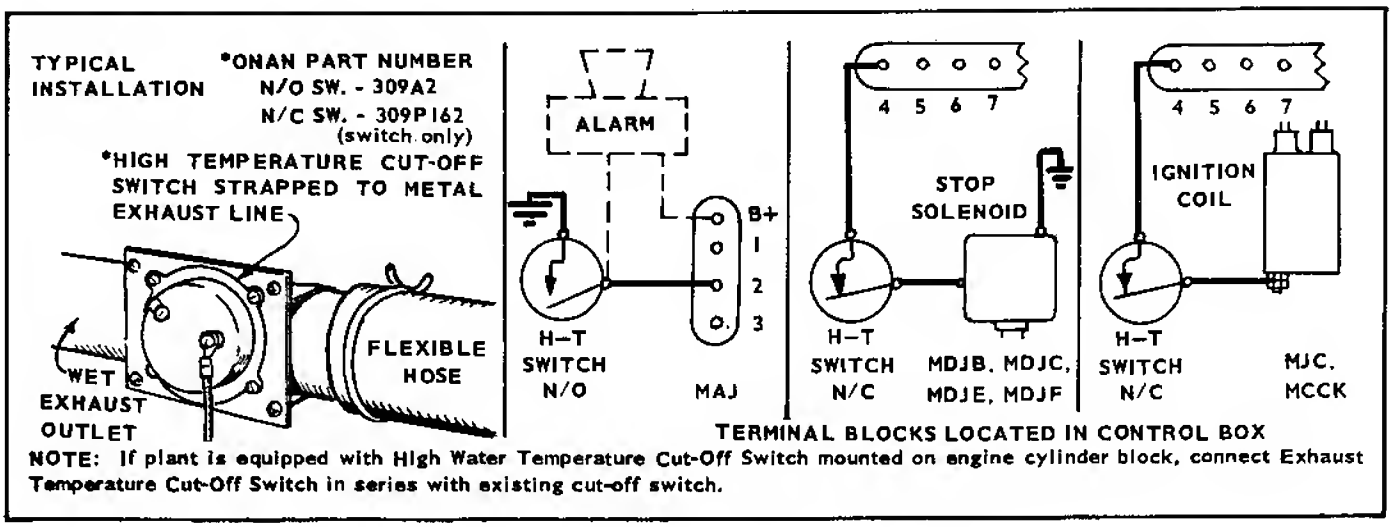
2. Engine stopping which creates a vacuum in the exhaust line. This could suck water back into the engine if the water was near enough. The vacuum results from two causes. On single-cylinder diesel electric plants, the engine is stopped by a decompression mechanism that opens the exhaust valve. On other plants, the engine rocks against compression as it comes to a stop and, if an exhaust valve is open, sucks a small amount of exhaust back into the cylinder.

There are several methods of eliminating water from the engine. All are based on separating the water injection point a few inches from the engine and installing a sharp drop in the exhaust line that water can't normally flow over. These methods are divided into two general categories – above water line installation and below water line installation.

When installing an electric plant with the exhaust manifold one foot or more above the load water line, inject the cooling water near the exhaust manifold. There are two types of exhaust elbows used. Most Onan marine units use a one-piece exhaust elbow while the rest use an elbow that has to be assembled (Figure 6). Plumbing connections should be made so cooling water is injected 4 inches below the manifold level.

NOTE: *For the exhaust elbow to be assembled, insert the water injection tube all the way.*

As an alternative, some mufflers are designed with an



NOTE: If plant is equipped with High Water Temperature Cut-Off Switch mounted on engine cylinder block, connect Exhaust Temperature Cut-Off Switch in series with existing cut-off switch.

FIGURE 4. HIGH TEMPERATURE EXHAUST SHUTDOWN SWITCH

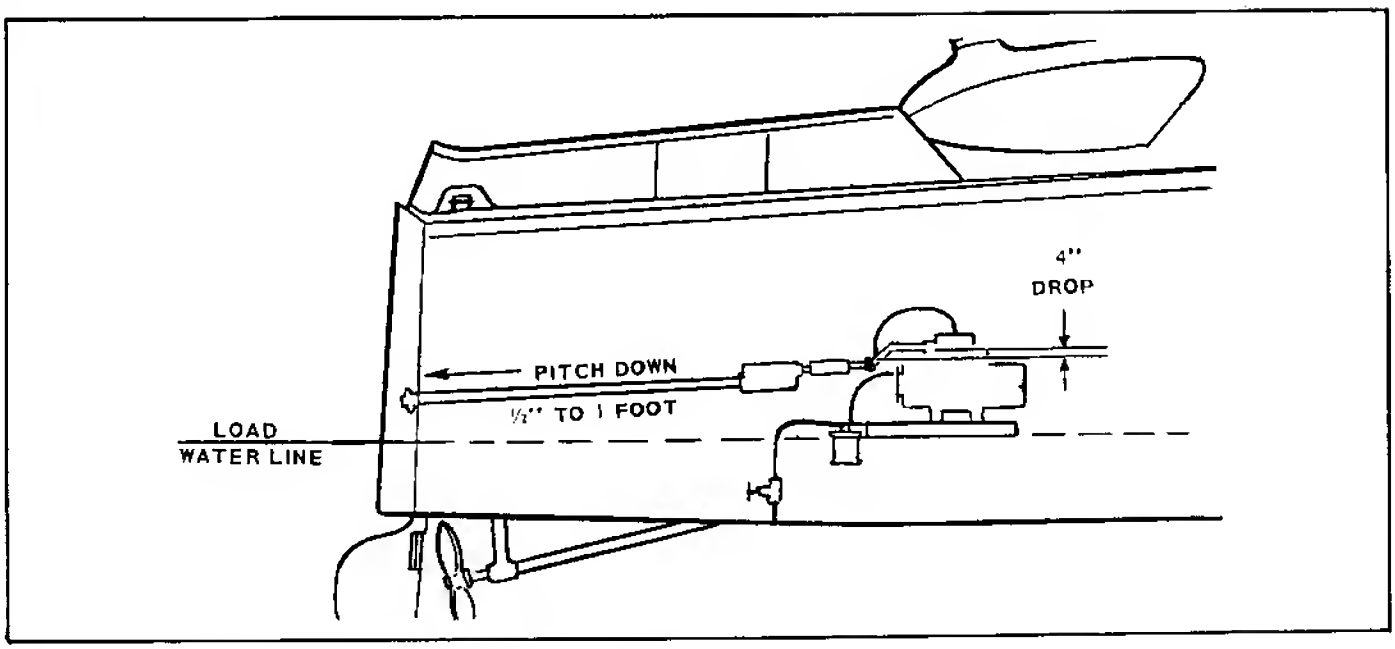


FIGURE 5. EXHAUST LINE INSTALLATION

integral water inlet so water can be injected at the muffler, and the muffler itself serves as an additional water barrier. This type of muffler should be installed as close as possible to the exhaust manifold, but with a section of flexible seamless metallic piping between muffler and manifold. Don't use the manifold as a muffler support; this puts excessive strain on the connecting exhaust line and can cause it to break.

When the electric plant is installed below or near the water line and an Aqualift muffler cannot be used (Figure 7 insert), the exhaust line must be run in a loop or hump above the water line to provide a water barrier and to raise the point of water injection above the water line (called a riser exhaust system). The higher point of the loop or hump should be at least 12 to 18 inches above the boat load water line (the higher the better). Inject exhaust cooling water on the outlet side of the hump and at least 4 inches below the bottom of the pipe at the top of the hump. When using this exhaust arrangement, install a condensation trap (Figure 9) as near the manifold as possible to catch any water condensing from the dry section of the exhaust line. Install either a valve or plug in the bottom of the trap to be drained at regular intervals.

NOTE: *To help break up the momentum of backwashing water in the exhaust lines before the water backflows to the electric plant, the muffler can be installed near the plant. Water rushing forward will pour into the muffler, dissipating its momentum.*

EXHAUST LINE INSTALLATION

From the point where water is injected into the exhaust line, pitch the exhaust line downward toward its outlet with a slope of at least 1/2" per foot of line. It allows draining during operation (prevents flooding) and when

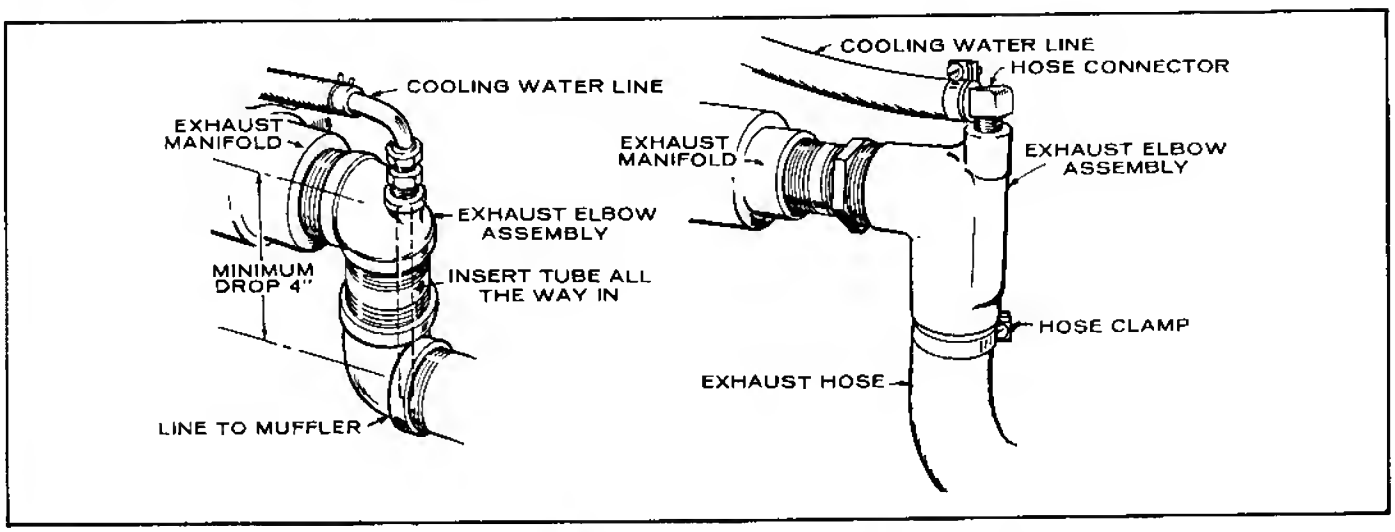


FIGURE 6. TYPICAL WATER INJECTION EXHAUST ELBOWS

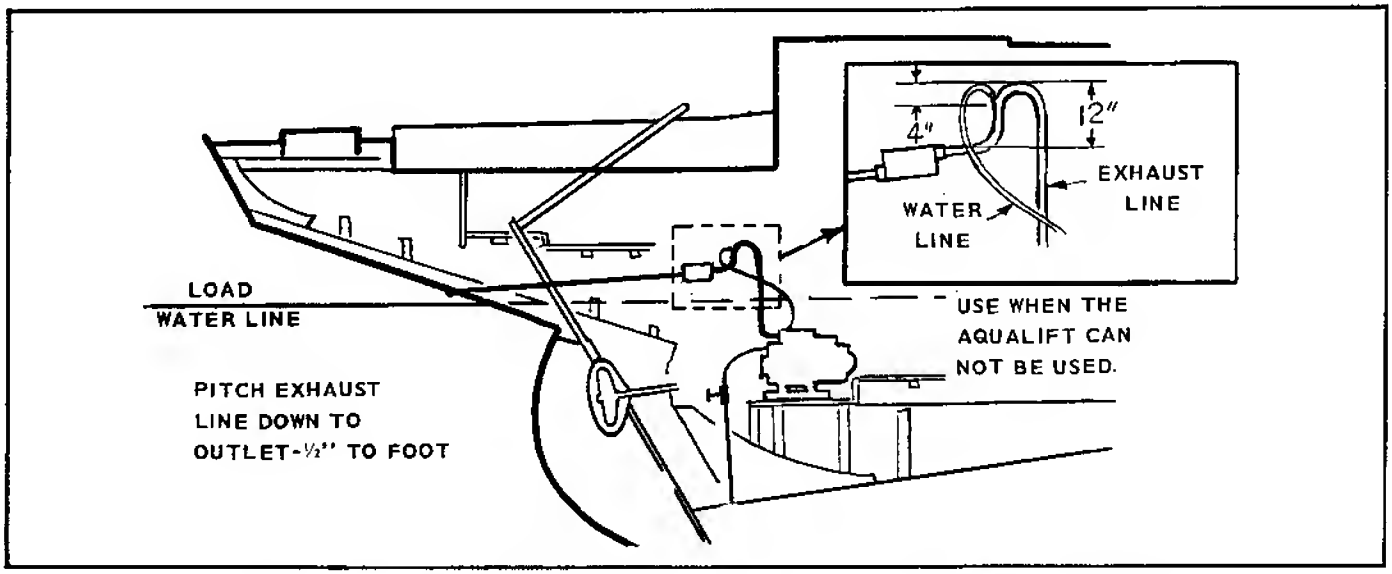


FIGURE 7. TYPICAL BELOW-WATER-LINE INSTALLATION, USING A RISER SYSTEM

stopped. If possible, run the exhaust line without any dips or pockets. Low sections allow water to build up in the line, creating back pressure and noise. If there is a dip in the exhaust line, install a drain at the lowest point so the exhaust line can be drained for storage.

The dry section of exhaust line should be either insulated or water-jacketed. An effective insulation can be made by bending sheet metal or expanded metal to form a thimble and then wrapping with asbestos tape (Figure 8). The thimble is necessary to prevent the tape from directly touching the exhaust line and burning off. Do not cover the ends of the thimble so air may flow next to the exhaust line (chimney effect).

Water jackets for the dry section of exhaust line are usually specially made. Figure 9 shows a water jacket made for the hump of a below water level exhaust installation. The water jacket and hump were prepared from refrigeration-type elbows.

The exhaust line should be as short as possible, with a minimum number of bends and gas tight throughout its length. Make the radius of any bend in the exhaust at least five times the diameter of the pipe. If metal piping is used, install either non-combustible hangers or blocks, such as automotive tailpipe hangers with vibration insulators to support it. Where the exhaust line passes through a non-watertight bulkhead, use a non-combustible packing.

Where exhaust lines pass through watertight bulkheads, the watertight integrity of the bulkhead must be maintained by installing graphite packing in stuffing tubes. In some cases, it will be to your advantage to run the exhaust line out the side of the boat, rather than out the transom as is normally done. This should be considered in cases where an excessively long line to the back of the boat could lead to water-pocketing or excessive exhaust back pressure.

MUFFLERS

A marine muffler silences the electric plant. Some mufflers have provision for an exhaust line water inlet; others are cooled by water through the exhaust line (Figure 3). Onan recommends the highly-efficient Aqualift muffler for electric plants (Figures 10 and 11) installed above or below the load water line (installation instructions are included with the Aqualift muffler).

CAUTION *If the exhaust manifold of the engine is below the load water line, install the siphon break kit listed in the Aqualift installation instructions.*

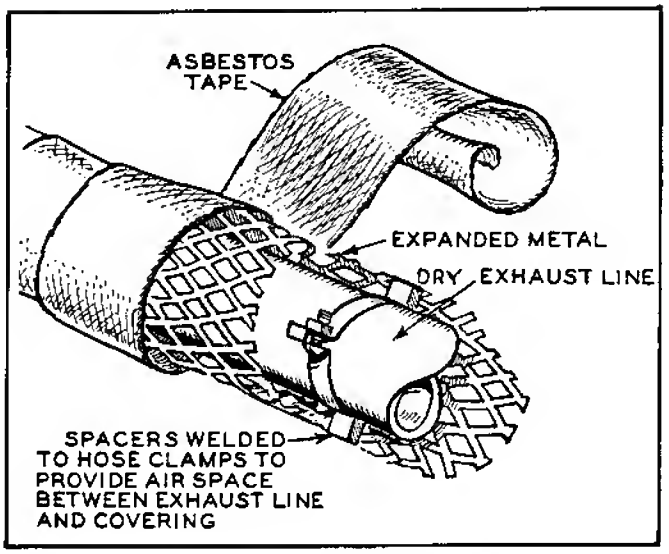


FIGURE 8. TYPICAL DRYSTACK EXHAUST PIPING

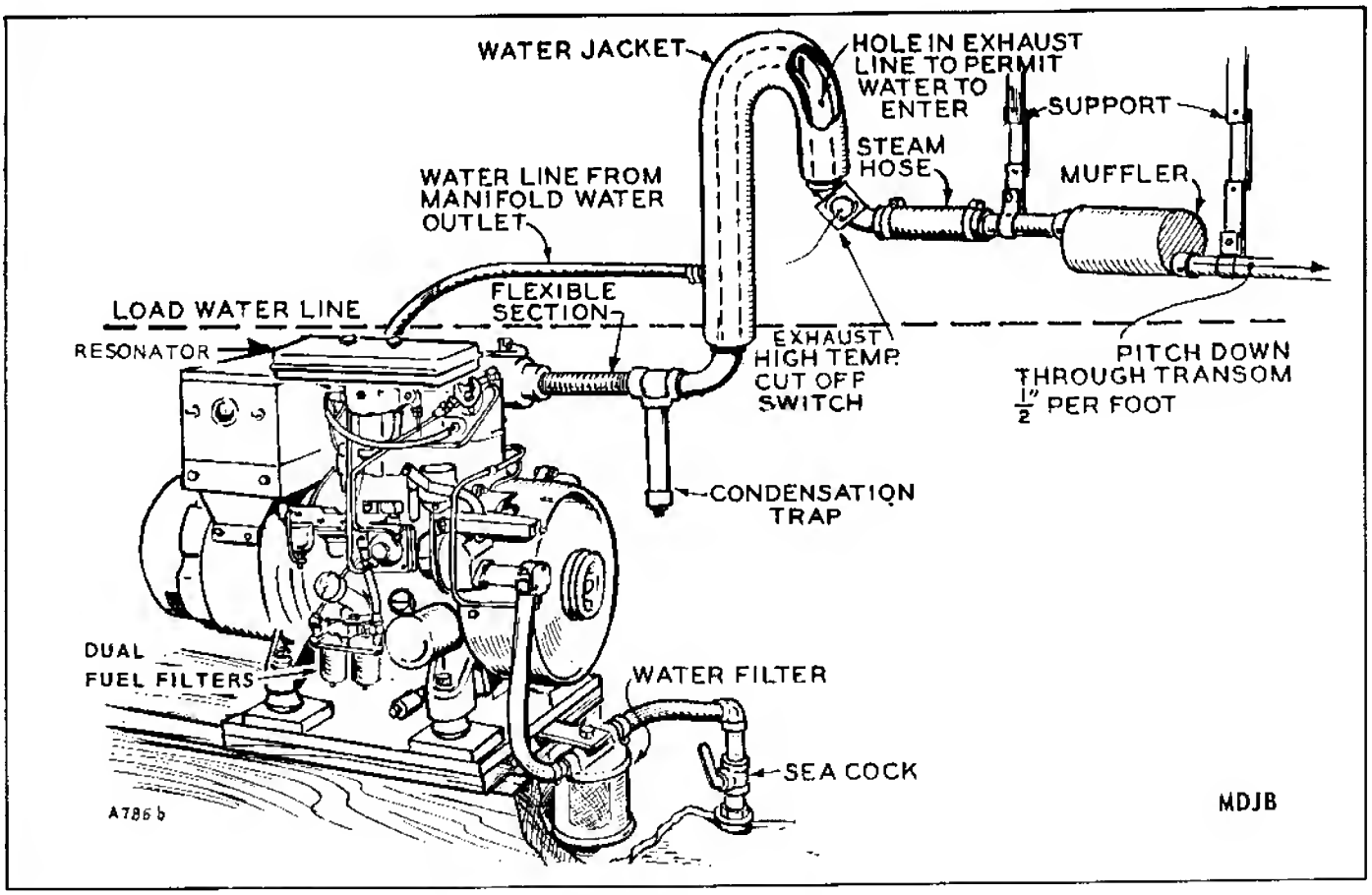


FIGURE 9. TYPICAL WATER-JACKETED RISER EXHAUST SYSTEM

Follow any special installation instructions included with the muffler or electric plant. Placement in the exhaust line, of course, depends on the type of muffler used, but always leave some tail pipe to improve silencing. Install the Aqualift muffler as near as possible to the electric plant. Inject exhaust cooling water at or before the muffler. If a neoprene muffler is used, install it near the plant but at least 2" after the water inlet to the exhaust line. Always leave at least 3" exhaust line between a neoprene rubber muffler and engine.

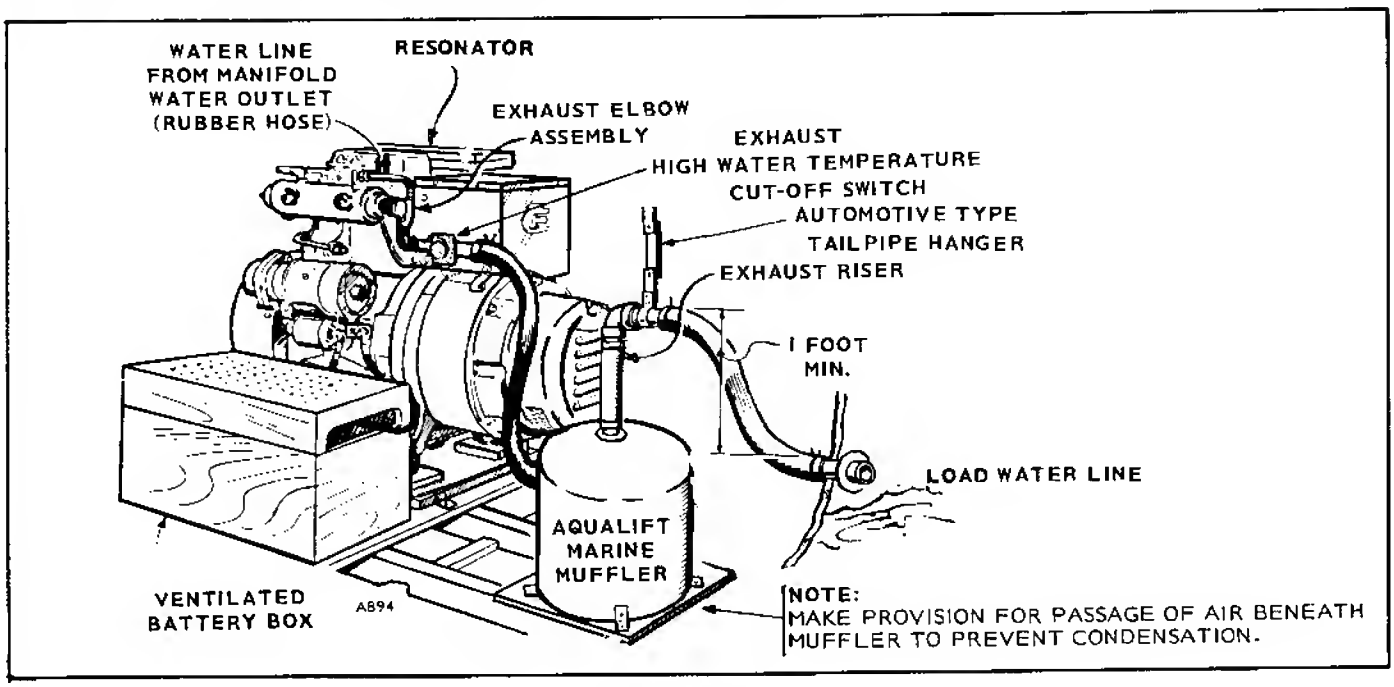


FIGURE 10. ABOVE-WATER-LINE INSTALLATION OF MDJB ELECTRIC PLANT

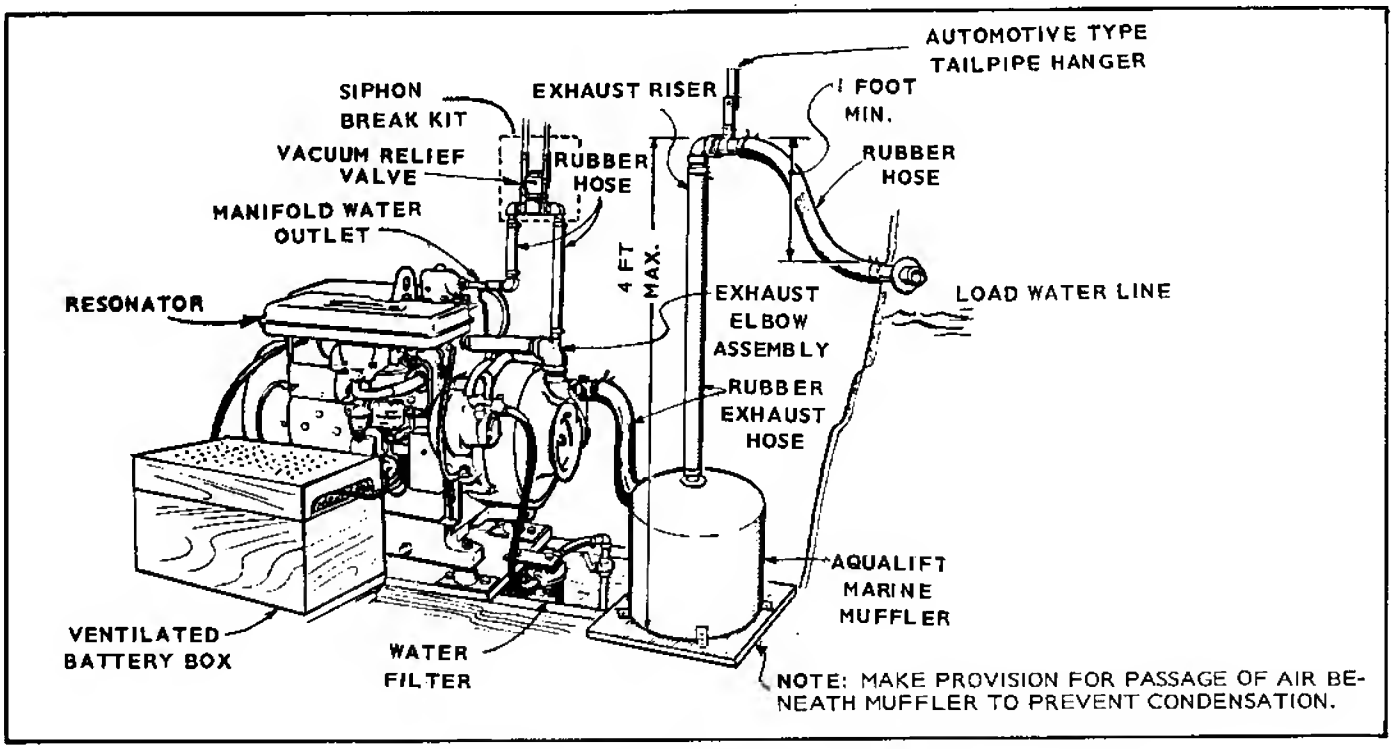


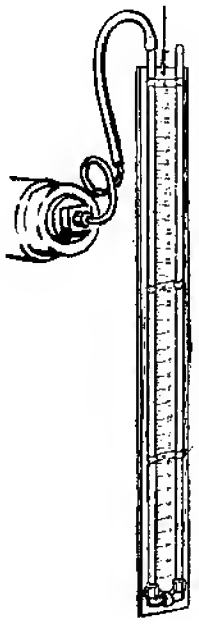
FIGURE 11. BELOW-WATER-LINE INSTALLATION OF MAJ ELECTRIC PLANT

Be sure any muffler is well supported, and in the case of a neoprene muffler, completely separated from the vessel's structure. If a neoprene muffler touches the vessel, it increases exhaust noise.

EXHAUST BACK PRESSURE

Exhaust back pressure is one of the most important criteria of an adequate exhaust system. If the installation is excessively long or questionable, back pressure should be checked before putting the unit into operation. Most Onan marine electric plants with a separate water-cooled exhaust manifold have a 1/8" pipe-tapped hole with pipe plug on one end of the manifold. An adapter will have to be made to check back pressure on other Onan units.

To check back pressure, connect a manometer (Figure 12) or pressure gauge on the manifold (as near as possible to the engine if there is no tapped hole), run the plant at full load and read the pressure. If readings are higher than the values in Figure 12, carefully investigate the exhaust system for restriction. Restriction will normally be caused by an excessively-long exhaust line, sharp bends, pockets which allow water to collect or improper muffling. Excessive back pressure will cause low power and damage the engine valves.



UNITS OF MEASUREMENT	BACK PRESSURE AT FULL LOAD
INCHES OF WATER	40
INCHES OF MERCURY	3
OUNCES/SQ.IN.	23.0 OZ.

FIGURE 12. MANOMETER INSTALLATION

FUEL SYSTEM

Because of the inherent fire and explosion hazards from fuels leaking in boats, it is important that the material, design, construction and installation of all fuel system components be to the highest possible standards. Use only products specified for marine applications.

WARNING *Because of the tremendous explosive potential of gasoline fuel, carefully plan the fuel system for the electric plant.*

FUEL TANKS

If the Onan electric plant and propulsion engines use the same fuel (gasoline or diesel fuel) the plant can usually be supplied from the main fuel tanks. There are two ways of supplying the electric plant from the main fuel tanks: 1) installing a special fitting at the tank outlet so two dip tubes can be fitted in the tank, or 2) installing a new outlet in the fuel tank. Of course, if the fuel tank has an unused outlet, this should be used. See Figure 13. Figures 14 and 15 show a two-tank gasoline system and a typical diesel system.

Operating the electric plant from a tee in the main fuel line can cause erratic generating plant operation. The plant fuel pump has neither the capacity nor power of the propulsion engine fuel pumps, so while the main engines are running under load, the electric plant could starve.

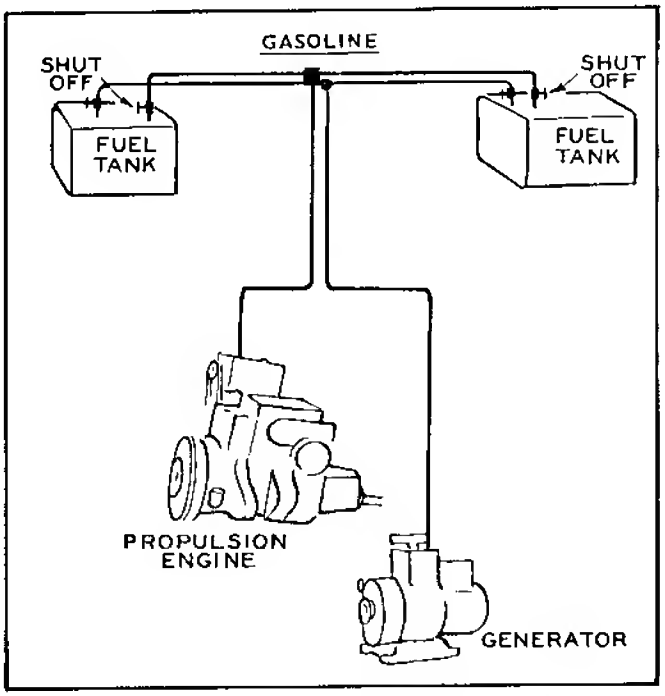


FIGURE 14. DUAL FUEL TANK INSTALLATION

Also, many gasoline fuel tanks have a siphon break hole near the top of the dip tube assembly (see sub section,

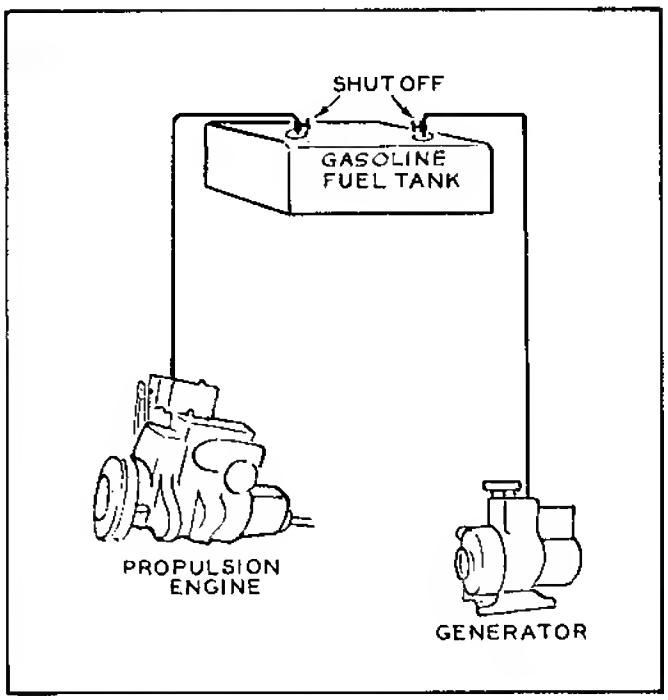


FIGURE 13. FUEL SUPPLY INSTALLATION

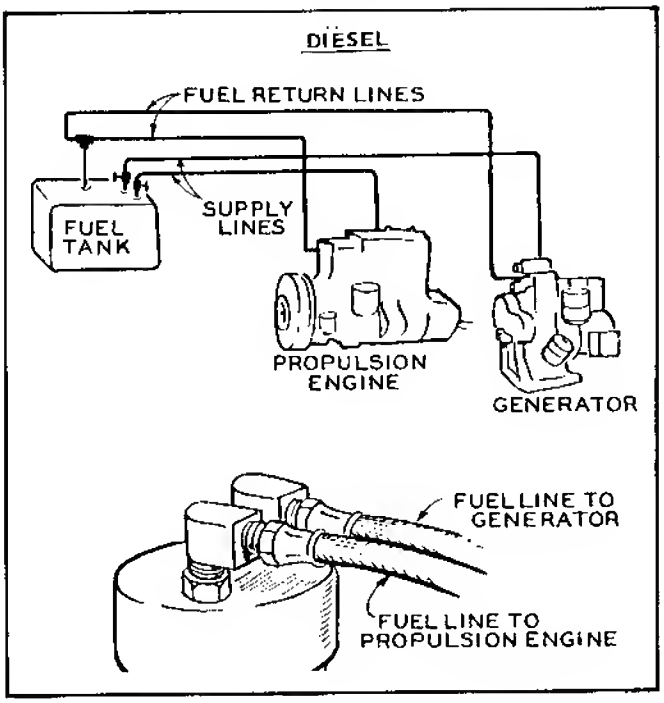


FIGURE 15. DIESEL FUEL SYSTEM

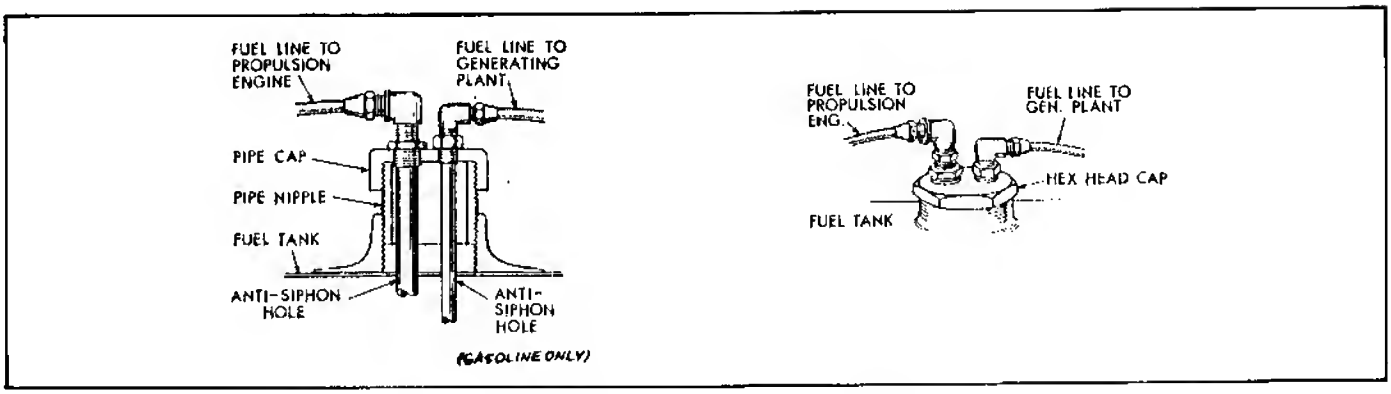


FIGURE 16. INSTALLING TWO FUEL LINES IN ONE TANK OUTLET

Siphon Break). In some cases, the hole is large enough that when the electric plant runs by itself, it draws only air through the siphon hole.

A separate fuel outlet from the tank eliminates these problems but requires removing the tank to braze or weld a new fitting into place. Also attempting to weld on a fuel tank, empty or not, is dangerous.

Figure 16 shows typical methods of installing a second dip tube in the original fuel tank outlet. If the fuel tank outlet fitting is large enough to accomodate two dip tubes, the required fittings can be built by a machine shop.

If a tee in the main fuel line is the only solution, locate it as near as possible to the fuel tanks. Some large boat manufacturers use this system exclusively, but design the complete fuel system around the combined fuel draw and siphon break requirements of both electric plant and propulsion engines. To determine if the system is adequate, test it after installation, first with electric plant and main engines running under load and then, with the electric plant running alone. If the electric plant dies when run alone and at no load, the difficulty can sometimes be eliminated by reducing the size of the anti-siphon hole in the fuel tank dip tube to about equal to a #75 drill. If the electric plant starves with the main engines running under load, the difficulty can sometimes be corrected by installing larger fuel lines between the tank and tee.

If none of the above solutions are adequate or if propulsion engines and electric plant use different fuels, a separate fuel tank (Fig. 17) will be required. Use only an approved fuel tank that has a nameplate giving the manufacturer and tank description. When installing a separate tank, locate it as close as possible to the electric plant compartment. Be sure it is accessible and can be removed for inspection.

Mount the fuel tank and secure it into position. The NFPA recommends that flat bottom tanks be installed on slatted wooden platforms to prevent moisture accumulation. Cylindrical tanks should be set in chocks or cradles and securely

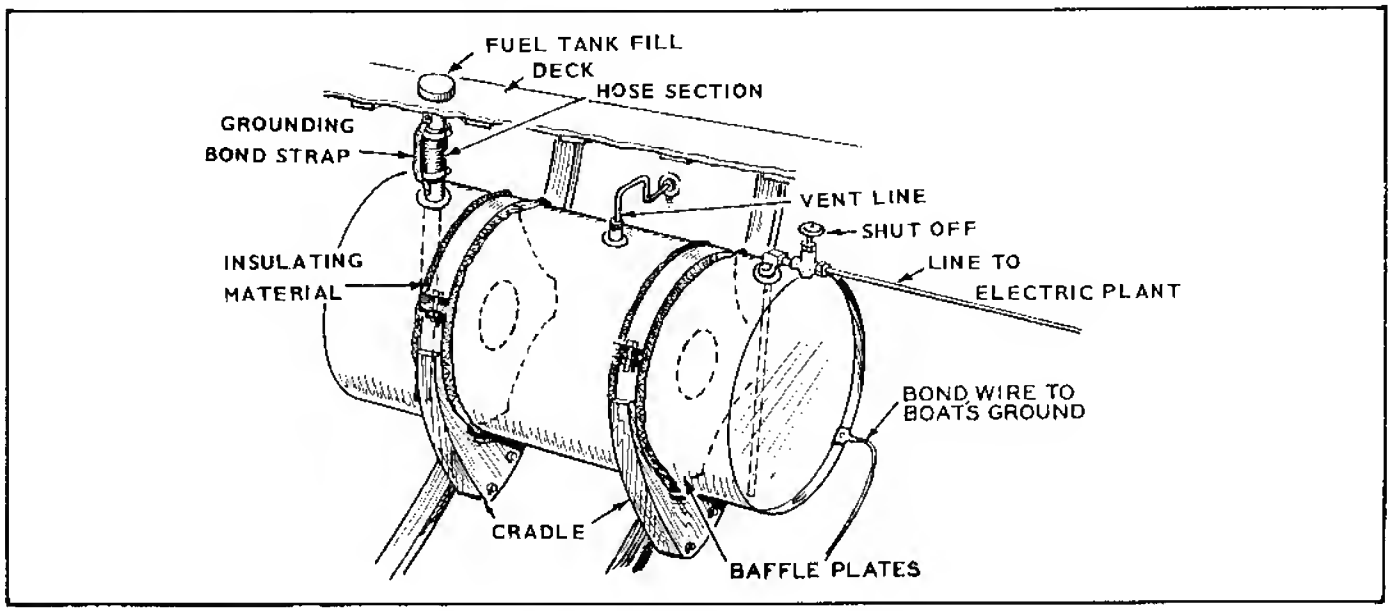


FIGURE 17. SEPARATE ELECTRIC PLANT FUEL TANK INSTALLATION

fastened. Small fuel tanks can be suspended from deck beams. Support and brace the tank to prevent any movement. Line up braces with the tank internal baffle plates. Insulate all wood or metal surfaces from the tank surface with a non-abrasive and non-absorbent material – rubber-impregnated heavy cotton fabric or oil-and acid-resistant plastics work well.

All fuel tanks must be electrically bonded to the boat ground. Also, bond the filler neck or opening to the tank if a hose is used between them (Figure 17).

Arrange the tank fill and vent pipes so there is no chance of fuel or vapor escaping into the bilge. Run the vent and fill pipes from separate openings in the tank. If a flexible section of fill pipe is used, install a separate grounding wire between the deck fuel plate and tank. Install the vent opening as remote from any other hull opening as possible and with a gooseneck so water won't enter the pipe. Install a flame arrestor of at least 30 x 30 mesh corrosion resistant screen on the vent opening.

When the tank is installed, test it for air tightness by sealing all openings and pumping air into the tank to a pressure of 4 to 5 psi. Pressure must remain steady. If not, the leak must be found before putting the system into service.

FUEL LINES

Use annealed copper tubing approved for marine installations, and flared connections. Run fuel lines at the top level of the tank to a point as close to the engine as possible, to reduce the danger of fuel siphoning out of the tank if the line should break. Be sure lines are accessible at all times and protected from mechanical injury. Use non-ferrous metal straps (without sharp edges) to secure the fuel lines.

Between the copper fuel line and engine, install an approved flexible non-metallic fuel line to absorb vibration and to insulate system from electrical ground current. The line must be long enough to prevent binding or stretching because of plant movement. Ground the copper fuel line to the plant with a suitable grounding strap (Fig. 18).

Install shut-off valves both at the tank outlet and at the plant; these are required by the Coast Guard and NFPA. Install the valve at the tank so it can be operated from outside the tank compartment – from the deck if possible.

As an option, a fuel solenoid (such as Onan #307P565 for 1/8" or #307P268 for 1/4" – both for 12-volt systems) can be used in place of one of the shut-off valves. The fuel solenoid is an electrically controlled valve that opens only when there is electrical power applied. It is preferable to

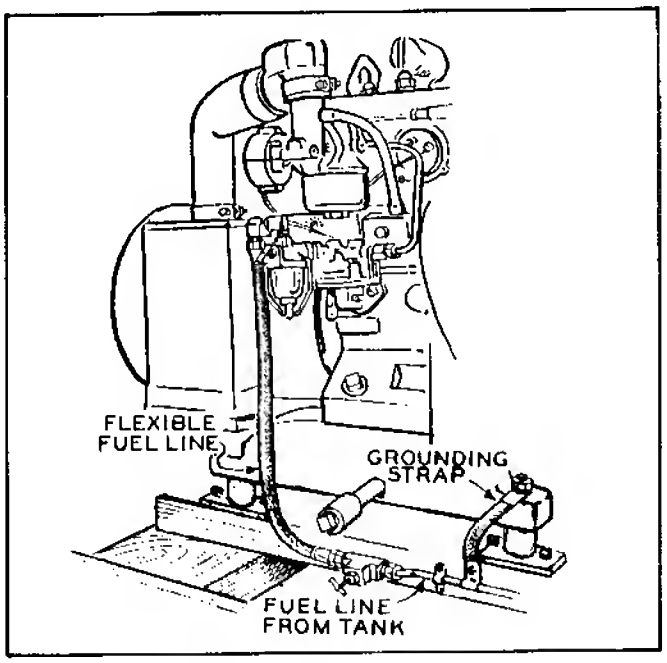


FIGURE 18. FUEL LINE-TO-FUEL TANK GROUNDING

mount the fuel solenoid on or near the electric plant. The fuel solenoid can be wired to open whenever the plant starts providing protection against fuel leakage when the plant is stopped. Another arrangement is to control the solenoid from a separate switch, so fuel to the plant can be shut off from the pilot station.

FUEL SYSTEM SIPHON-BREAK

A carburetor float valve cannot always be depended on to hold back fuel if there is a gravity feed from the fuel tank. When the tank is installed above the engine level on gasoline plants, a siphon break is necessary to prevent the fuel from emptying into the carburetor if the float valve doesn't hold closed. This also prevents the fuel from siphoning out if the fuel line breaks at a point below the fuel level.

Most gasoline marine fuel tanks have an anti-siphon orifice drilled near the top of the fuel outlet pipe before installation. Because of the relatively small fuel draw of the electric plant's fuel pump, it draws only the air from the orifice when used alone with a tank designed for the main engines. This is one of the reasons for using a separate fuel tank connection for the plant. However, if the proper size orifice is used (about #75) in either a separate tank or a separate outlet from the main tank, it will function as a siphon break.

NOTE: *Fuel system siphon breaks should not be used with diesel electric plants. It isn't necessary and, in addition, introduces air into the fuel which causes erratic operation.*

When using a Bendix electric fuel pump, install it upside down with the filter on top. This avoids fuel spillage when cleaning the filter.

COOLING SYSTEM

Three types of cooling are in general use today; raw water (direct) cooling (Figure 20), heat exchanger (fresh water) cooling (Figure 21) and keel or skin (fresh water) cooling (Figure 22).

NOTE: *Throughout this bulletin, flotation water drawn into the boat for engine cooling will be called raw water. Water recirculating through a closed system will be called fresh water.*

Raw water cooling systems use an engine-mounted pump to draw water directly from the sea, through the cooling system, and out through the exhaust system. Raw water passes directly through the engine cooling jacket.

To eliminate raw water in the engine cooling jacket and the resulting sediment (salt, silt, etc.) deposits, the heat exchanger and keel cooler were developed. Both of these systems use fresh water in a closed system to cool the engine. Raw water cools the fresh water in the heat exchanger or keel cooler and the fresh water returns to the engine water jacket. This system is similar to an automotive radiator – a fixed quantity of fresh water circulated between engine and cooling device – but differs, because water, not air, cools the engine coolant. Fresh water and raw water never mix so the engine water jacket stays clean.

Heat exchangers and keel coolers differ in the method used to cool the fresh water. A heat exchanger is made of a bundle of tubes with a shell around them (Fig. 19). Fresh water circulates through the shell and raw water through the tubes, and the raw water cools the fresh water. This means there are two separate water systems, a fresh water or closed system, circulating water between heat exchanger and engine, and a raw water system circulating raw water through the heat exchanger. On the other hand, a keel cooler is simply pipes or finned pipes below the vessel's hull, next to the keel. Skin cooling is where a section of the hull has an extra skin and the fresh water passes between the two and the external skin cools the water. The engine pumps the heated fresh water through the pipes where it's cooled by the flotation water. No raw water for engine cooling enters the vessel, but a separate raw water inlet and pump are needed to cool the exhaust system.

Each of the above cooling systems has its own advantages and disadvantages, and each should be used in particular conditions. See Table 4.

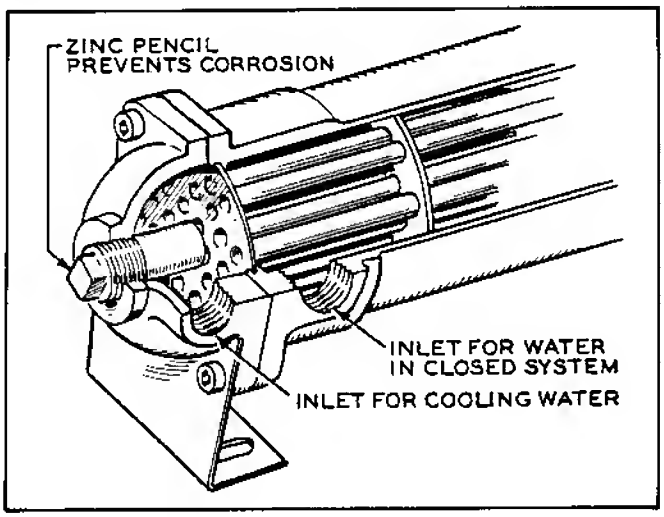


FIGURE 19. HEAT EXCHANGER

WATER PUMP

Two types of pumps are in general use today; the centrifugal pump and the neoprene impeller pump. Each has special advantages and disadvantages (Table 5).

Onan marine plants are equipped with an engine-mounted neoprene impeller pump. Because of its sensitivity to hot water, this pump shouldn't be used in closed water systems. It works well as the pump for a raw water cooling system, the pump for the raw water side of a heat exchanger cooling system, and a raw water pump for exhaust cooling water in a keel cooler system.

Important: *If the boat is to be used extensively in contaminated water where a strainer can't remove most of the dirt, install a centrifugal pump and filter below the water line as a raw water pump. Dirty water can still cause block plugging; therefore heat exchanger, keel cooling or skin cooling should be used under these conditions.*

PLUMBING

To cool the plant properly under all conditions, the plumbing must be properly planned and executed. Excess plumbing lengths increase flow resistance and reduce cooling. Air leaks in the water system reduce cooling, cause corrosion, and can even destroy a rubber impeller pump. The neoprene impeller pump should never be run dry and should be primed in the plant's initial state and at the beginning of each season.

TABLE 4. ADVANTAGES AND DISADVANTAGES OF VARIOUS MARINE COOLING SYSTEMS

COOLING SYSTEM	ADVANTAGES	DISADVANTAGES	AREAS WHERE NORMALLY USED
RAW WATER	Direct Simplest Lowest initial cost	Raw water through cylinder block leaves deposits. Increased thermal shock due to cold water entering block Unable to use rust inhibitor or antifreeze	Fresh water lakes Uncontaminated rivers
HEAT EX-CHANGER	Eliminates raw water in cylinder block. Allows use of rust inhibitor and anti-freeze in closed water system. Lower water temperature differential reduces thermal shock on cylinder block. Improves temperature control of engine.	More costly than raw water. Some chance of clogging heat exchanger in contaminated water. (raw water side) Extra plumbing inside craft.	Salt water River where the water contains debris or is heavily silted.
KEEL COOLER OR SKIN COOLING	Single fresh water system, no raw water—no chance of clogging engine water passages in dirty water. Eliminates raw water in cylinder block. Allows use of rust inhibitor and anti-freeze in closed water system. Lower water temperature differential reduces thermal shock on cylinder block. Improves temperature control of engine.	Extra plumbing inside craft. Extra device on outside of vessel to increase drag. (Keel Cooler)* Reduced cooling capacity when vessel not moving. Extra water system needed to provide sea water for exhaust cooling. External keel cooler invites damage. Boat must be dry-docked to service external keel cooler.	Rivers where the water contains debris or is heavily silted. Salt water.

*Skin cooling does not have external protrusions from hull.

TABLE 5. ADVANTAGES AND DISADVANTAGES OF WATER PUMPS

TYPE OF PUMP	ADVANTAGES	DISADVANTAGES	USES
NEOPRENE IMPELLER	Provides suction lift Provides a more positive displacement than centrifugal pump Less sensitive to back pressure than centrifugal pump	More power required than centrifugal Neoprene impeller deteriorates with use Use in hot water shortens life Some rust inhibitors will destroy impeller	Use where suction lift is required Raw water system when pump is located above water line
CENTRIFUGAL	Requires very little service or inspection Can be used in hot water without deterioration Greatly minimized wear in silted or dirty water	No suction lift Flow changes with back pressure	Use when hot or dirty water would shorten Neoprene impeller life Fresh water cooling system Raw water system if pump is below waterline

Use line of the proper size, following recommendations in Table 6. Increase the line size for runs over 5' in length.

Water lines can be either copper tubing or flexible hose. In any case, use a section of flexible hose on the water inlet next to the electric plant. Use another flexible section on the water outlet, before it enters the exhaust line. This flexible section must be long enough to eliminate transmission of vibration.

NOTE: *Unless the raw water is very clean, Onan recommends using a water filter in the water line to protect the cooling system (Figure 20).*

Don't install the plant water inlet directly in line with other water inlets. This could reduce the amount of raw water received by the plant and cause it to overheat when the boat is underway. Stagger the water inlets. Always use a flush-type thru-hull water inlet when using an Aqualift marine muffler with an electric plant (see Figure 20).

DIRECT COOLING SYSTEM (See Figure 20)

ONAN marine plants are equipped with a pump, all piping between the engine-mounted pump, the cylinder water jacket and the water-cooled exhaust manifold. Install a through-hull fitting, sea cock, and strainer. Run the water line from the through-hull fitting to the engine-mounted pump, using a section of flexible hose next to the plant. From the engine water outlet, the water line should run to the exhaust system water inlet.

TABLE 6. COOLING SYSTEM CONNECTING SIZES AND RECOMMENDED HOSE SIZES

PLANT	INLET THREADED PIPE FITTING SIZE (INCH)	OUTLET THREADED PIPE FITTING SIZE (INCH)	MINIMUM RECOMMENDED HOSE INSIDE DIAMETER (INCH)
MAJ	1/8	1/8	3/8
MJC, MDJA MDJB MCCK, MDJE	1/4	3/8 (Hose Adapter Furnished)	1/2
MDJF	3/4		3/4

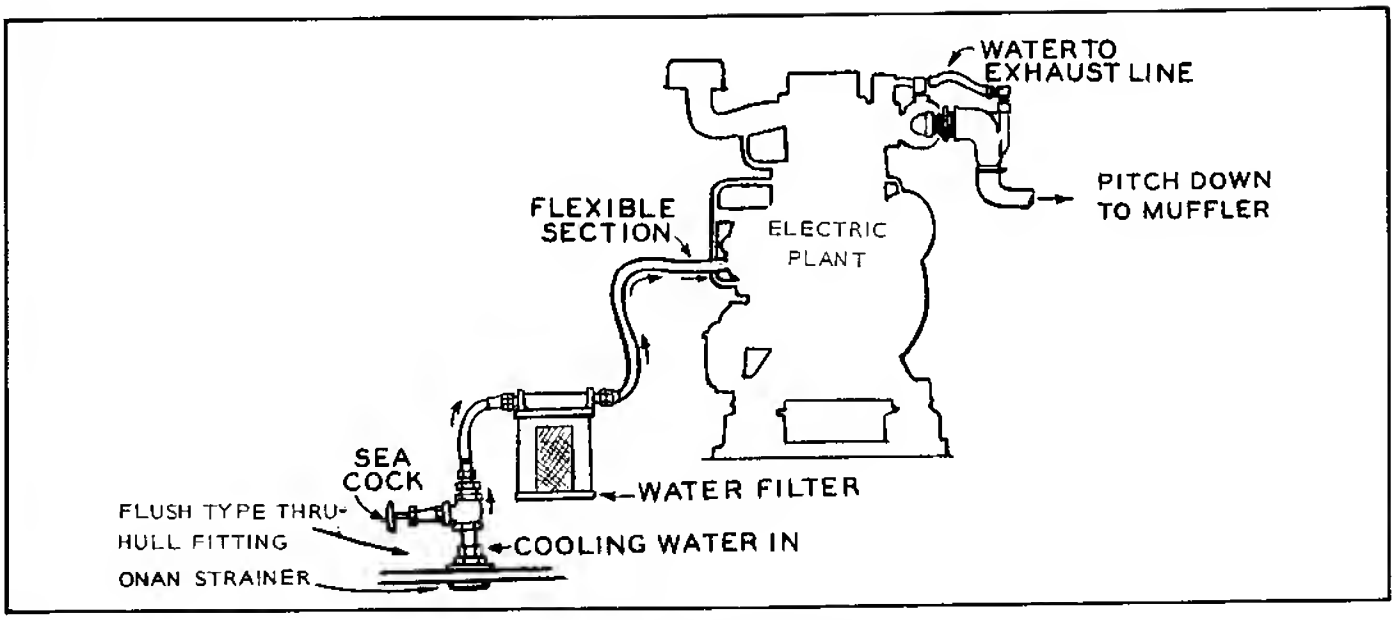


FIGURE 20. DIRECT COOLING SYSTEM

The most important part of a direct cooling system installation is to eliminate all air leaks and maintain enough water flow to cool the engine. After the installation is completed, test the water flow and check for air leaks (See Cooling System Tests).

HEAT EXCHANGER COOLING

Heat exchanger cooling (Fig. 21) is available as a factory installed option for all Onan marine electric plants except the MAJ. A heat exchanger kit for field conversion from direct cooling is also available for most Onan marine electric plants except the MAJ.

When using these engine-mounted heat exchanger units, follow the same installation procedure as with a raw water model. The installation requires a through-hull fitting, sea cock, strainer, water lines to the neoprene impeller pump, and water lines from the heat exchanger raw water outlet or exhaust manifold (depending on the plant model) to the exhaust system water inlet. All closed-water-system plumbing from the neoprene impeller pump to the heat exchanger and exhaust manifold is factory installed. If any brand of heat exchanger other than Onan is to be installed, several special precautions must be taken –

1. The heat exchanger must be capable of cooling the plant under all load conditions. The Onan system was designed to cool the plant properly with raw water inlet temperatures as high as 85°F. A heat exchanger manufacturer can select a model from the data furnished in Table 7.

2. The raw and fresh water pumps must be capable of circulating adequate water through the engine and plumbing. Minimum water flow required by Onan electric plants is given in Table 7. The heat exchanger will also have minimum flow requirements which must be met if it is to cool up to its capacity.

3. An expansion tank must be selected for the system that will allow adequate water expansion for the fresh water. The expansion tank must include a pressure cap capable of preventing the system from boiling after the plant is shut down. Because the cylinder block is hotter than the cooling water, water in the block heats up considerably immediately after shut down.

4. The electric plant cooling system must be modified slightly to reduce or eliminate the cylinder block water by-pass so the block will receive adequate water.

Cooling system components can be either plant-mounted or separately located. Always install the expansion tank above the centrifugal pump so it supplies a constant water supply to the pump. A centrifugal pump won't pump against suction, so it must have this supply of water to operate.

If the electric plant uses a water cooled exhaust manifold, it should be included in the fresh water system. When cooled by raw water, the manifold quickly gathers scale and becomes clogged. Be sure to add the heat rejected by the manifold to the electric plant heat rejection when determining heat exchanger capacity.

KEEL COOLING (OR SKIN COOLING)

If you decide to use a keel cooler (Fig. 22), several precautions must be taken. First, a larger keel cooler will be required for the electric plant than would be required for an equal sized propulsion engine. This is because the electric plant is often required to operate at its heaviest load when the boat isn't moving – the same time when the keel cooler (or skin cooler) capacity is at its lowest. Secondly, if the keel cooler installation is to be built up from

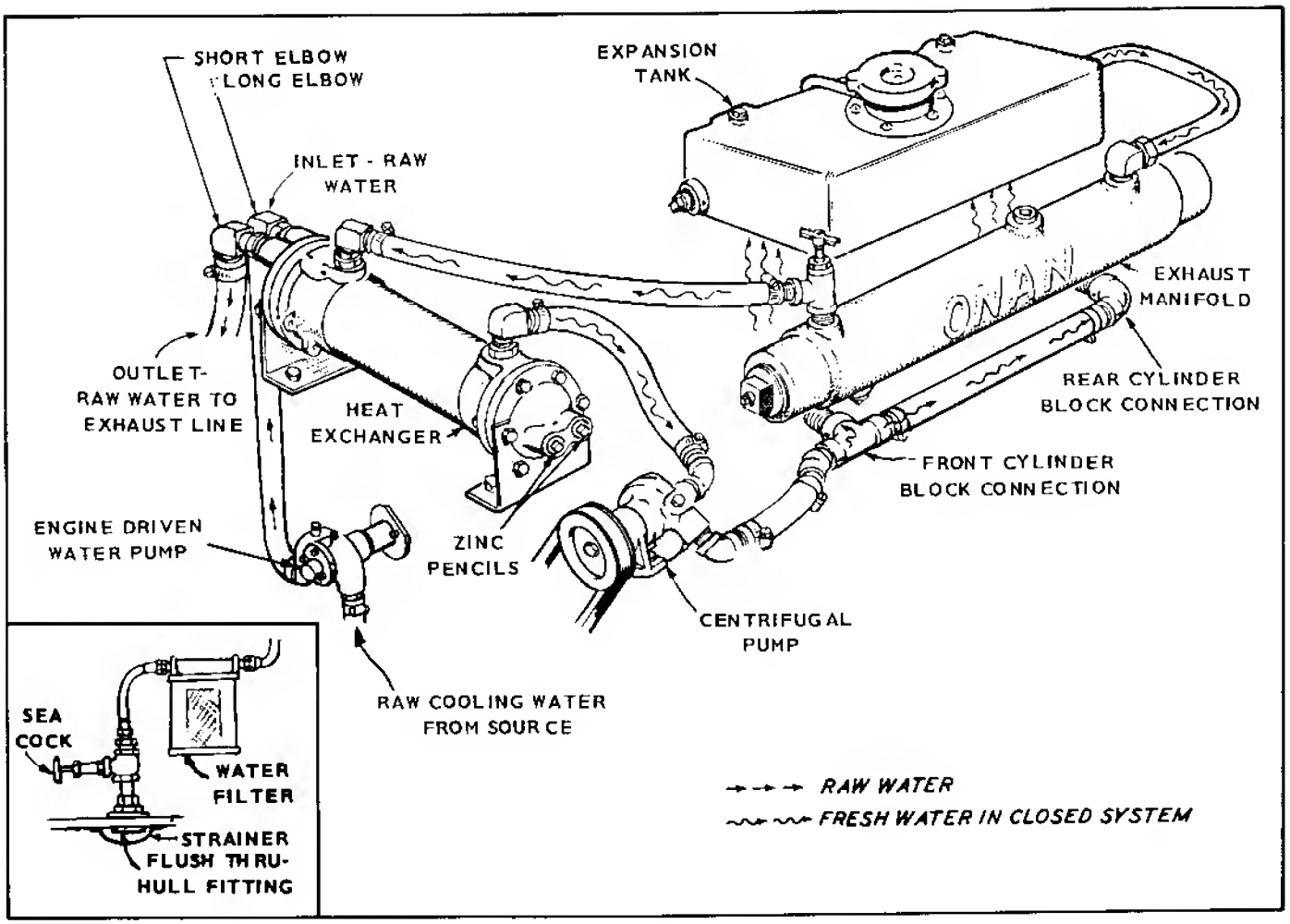


FIGURE 21. HEAT EXCHANGER COOLING

an Onan raw water cooled plant, the same precautions must be taken as for installing a heat exchanger of your own choice.

Onan has available (see Fig. 23) a keel cooler model for the following plants: MDJA, MDJB, MDJC, MDJE, MDJF. This special model includes an electric plant modified to operate with fresh water cooling, an engine mounted neoprene impeller pump to supply exhaust cooling water, and an engine-mounted fresh water pump. A keel cooler, expansion tank and plumbing must be customer-supplied. Onan recommends that a keel cooler manufacturer be consulted to select the proper keel cooler model to be used with the generating plant. Furnish the manufacturer with the information given in Table 7 for your electric plant. Note these special requirements.

1. The electric plant often operates at full-load when the boat is stopped. The keel cooler should be selected to properly cool the plant at full-load when the boat is not underway.

2. The keel cooler should be selected to properly cool the plant at the maximum flotation water temperature the boat will ever encounter. Onan normally uses a temperature of 85°F.

3. The keel cooler should be large enough to cool also

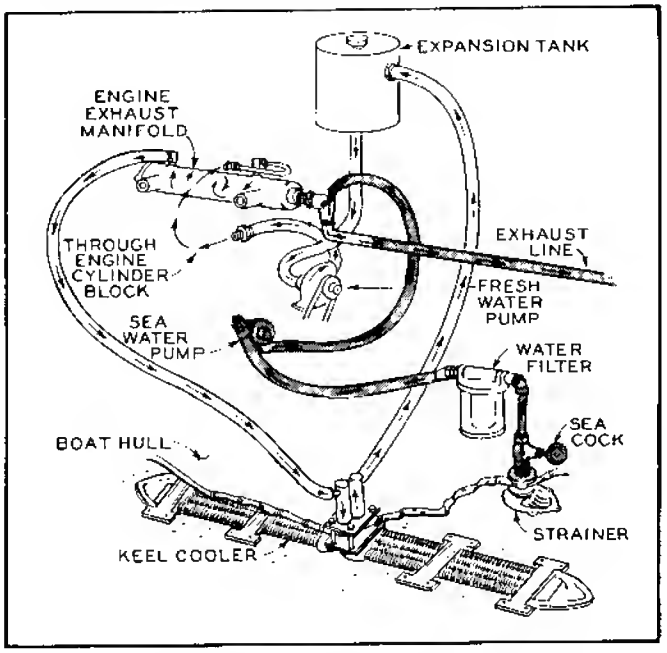


FIGURE 22. KEEL COOLING SYSTEM

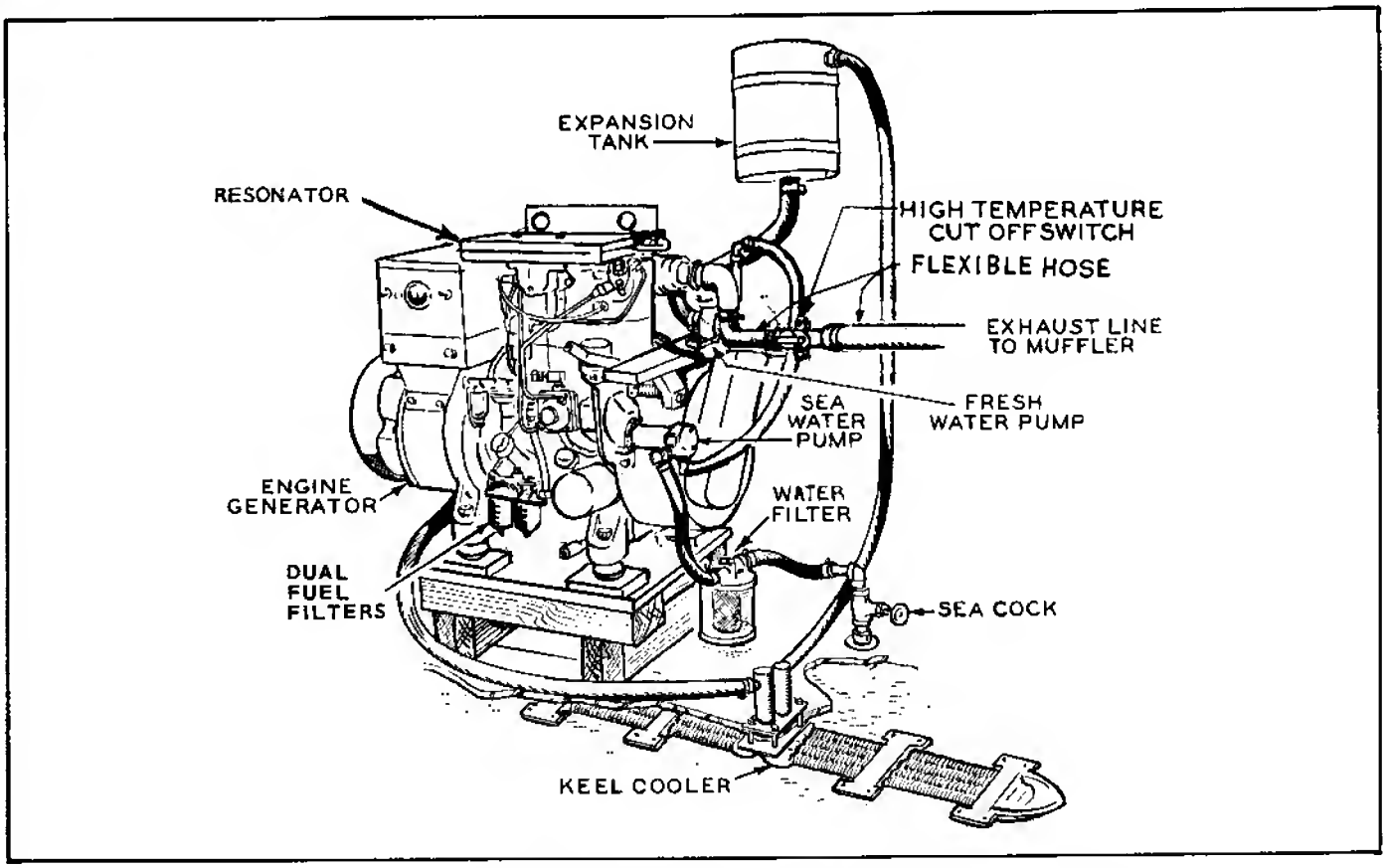


FIGURE 23. KEEL COOLER INSTALLATION OF MDJB AND MDJE ELECTRIC PLANTS

the water cooled exhaust manifold. All plants in Table 7 that have water cooled exhaust manifolds show the characteristics of the plant with manifold included.

Because of the many keel cooler brands available today, and the great diversity of applications, Onan doesn't recommend a particular keel cooler or keel cooler manufacturer.

NOTE: *If a dry stack exhaust system is to be used, the engine-mounted neoprene impeller pump isn't required. The pump should be removed and replaced by a solid plate.*

For the MDJA and MDJB generating plants 1/2" hose should be used throughout the closed water system. The MJC, MDJC, MDJE and MDJF plants use 3/4" hose.

COMBINING WITH PROPULSION ENGINE COOLING SYSTEM

Onan doesn't recommend combining the electric plant cooling system with the propulsion engine cooling system. This involves a great deal of experience and engineering knowledge as well as complete characteristics of both the electric plant and propulsion engines.

CAUTION *Propulsion engines use scoop-type water inlet fittings which must not be used with Aqualift muffler equipped electric plants.*

COOLING SYSTEM TESTS

Before the electric plant is put into service, the following tests should be applied to the cooling system.

Any water system involving a neoprene impeller pump must be completely free of air leaks. Air in the system will reduce pump lubrication and shorten impeller life.

To check the raw water system for air leaks, disconnect the engine outlet water hose and insert it into a bucket of water. Run the plant and watch for bubbles in the discharge. Any bubbles indicate an air leak into the cooling system which can damage the neoprene impeller pump, rubber exhaust line, or a neoprene rubber muffler. Do not run the plant for more than one minute if the cooling system is faulty, as this may damage a water-cooled exhaust system as well as the engine. Also, the raw water system should be checked for correct water flow. This can be done by allowing the plant to run until warm, and then disconnecting the water outlet and measuring the water that flows in one minute or time in seconds for one gallon.

The only check required of the closed water system is to be sure there are no water leaks at any connections and that the minimum water flow is maintained. If necessary, the water temperatures of the system can be measured and

compared with the values in Table 7 to assure adequate cooling.

NOTE: *All Onan marine electric plants contain a high-temperature shutdown switch that shuts the plant down before damage from overheating occurs.*

NOTE: *It is not recommended that a fresh water-making system be used unless installed according to the manufacturer's recommendations and the system specifically designed for the Onan marine electric plant.*

Incorrect plumbing and piping can disrupt the normal cooling system and its capacity.

TABLE 7. ONAN MARINE ELECTRIC PLANT COOLING REQUIREMENTS AT 1800 RPM RATED LOAD

MODEL	KW RATING (MARINE-DUTY	BORE (IN.)	STROKE (IN.)	MINIMUM ENGINE WATER FLOW (GPM)		PRESSURE DROP ACROSS ENGINE & MANIFOLD AT 1800 RPM & RECOMMENDED FLOW (INCHES OF MERCURY)		TEMP. RISE* (DEGREES F) AT RATED WATER FLOW & RATED LOAD (INCLUDES MANIFOLD)		HEAT EXCH. COOLING AVAILABLE FROM ONAN	COOLING SYSTEM CAPACITY (PT) WITH HEAT EXCHANGER
				DIRECT COOLING	HEAT EXCH. OR KEEL COOLER JACKET WATER	DIRECT COOLING	HEAT EXCH. COOLING	DIRECT COOLING	HEAT EXCH. OR KEEL COOLER JACKET WATER		
0.6MAJ (DC)	▲ 600	2 3/4	2 1/2	.75	†	.85	†	†	†	NO	†
1.5MAJ (DC)	▲ 1,500	2 3/4	2 1/2	.75	†	.85	†	†	†	NO	†
2.5MAJ	★ 2,500	2 3/4	2 1/2	1.0	†	†	†	†	†	NO	†
4.0MCCK	4,000	3 1/4	3	3.5	3.0	†	†	†	†	YES	7
6.5MCCK	6,500	3 1/4	3	3.5	3.0	†	†	†	†	YES	7
10.0MJC	10,000	3 1/4	3 5/8	4.0	4.7	7.0	9.0	44°	31°	YES	19
15.0MJC	15,000	3 1/4	3 5/8	4.0	4.7	7.0	9.0	44°	31°	YES	19
3.0MDJA	3,000	3 1/4	3 5/8	3.4	3.66	6.75	11.0	13°	10°	YES	4.5
6.0MDJB	6,000	3 1/4	3 5/8	3.8	3.0	13.5	14.75	21°	26°	YES	9
7.5MDJE	7,500	3 1/2	3 5/8	3.8	3.0	13.5	14.75	26°	32°	YES	9
12.0MDJC	12,000	3 1/4	3 5/8	4.0	4.7	7.0	9.0	44°	31°	YES	19
15.0MDJF	15,000	3 1/2	3 5/8	4.0	4.7	7.0	9.0	55°	38°	YES	19

* - Engine outlet temperature depends on inlet water and engine but should not exceed 200°F including exhaust manifold for any engine.

▲ - Direct current rating.

★ - Rating at 3600 rpm.

† - Data not available or not applicable.

BATTERIES

The electric plant batteries should be installed as close as possible to the plant but not directly under the generator. If installed in a separate compartment, be sure the compartment is well ventilated to prevent any accumulation of hydrogen gas generated during battery charging. Mount the batteries in an acid resistant tray on a platform above the floor and secure them against shifting. If batteries are in the engine compartment, always install a non-metallic cover (such as peg board, Fig. 24) over them to prevent accidental sparks from objects dropped on the batteries.

BATTERY CHARGING PLANTS

When connecting batteries to a battery charging plant, connect the batteries directly to the plant. This prevents any one from trying to operate the plant with batteries disconnected which would damage the generator. On 24- and 32-volt plants, install a fused double-pole single-throw switch as specified in the plant operators manual between the batteries and plant. These models are fused to prevent excessive damage in case of an accidental short at the plant.

Connect the load to the battery side of the fused switch and install a separate switch and fuses rated for the load between the battery and load.

Don't attempt to combine the batteries with other battery charging systems (see the next sub section).

ALTERNATING CURRENT PLANTS

Connect the batteries directly to the control box connections as specified in the plant operators manual. For 12-volt plants, use the wire sizes specified in Table 8. Cable size is especially important with exciter cranked plants, where insufficiently sized battery cables could cause the armature to stall during starting, burning the commutator. Be sure all connections are tight. Always use batteries at least as large as specified in the operators manual. All

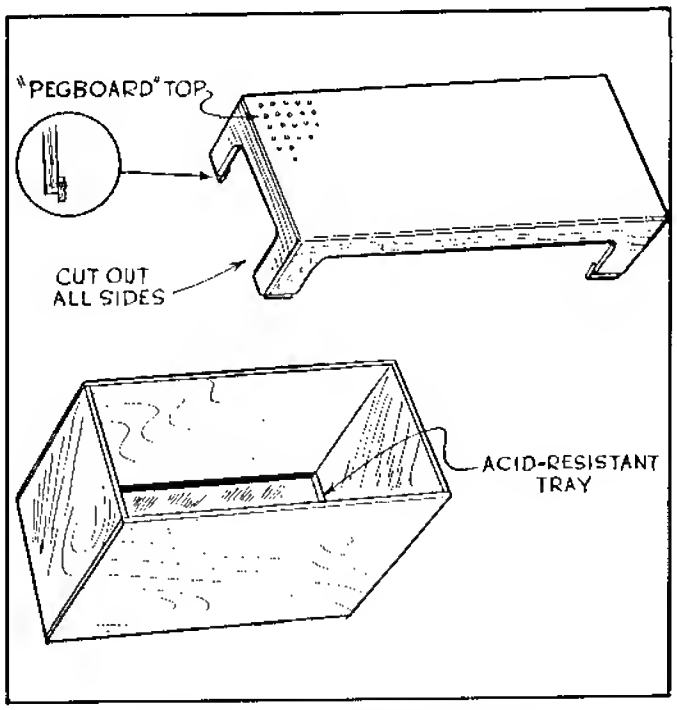


FIGURE 24. BATTERY TRAY AND COVER

exciter cranked plants require at least 105-amp. hr. battery capacity.

Onan recommends using two 6-volt, 105-amp.-hour batteries in series to meet this requirement.

Onan recommends using batteries separate from the propulsion engine battery system. The propulsion engine starting batteries are essential to engine starting - separating them from other equipment eliminates the chance of discharging the batteries through misuse of the other equipment. Also, the battery-charging systems of the electric plant and propulsion engines are not always compatible, and can cause damage if connected together. To assure correct electric plant operation and fast starting, do not connect elec-

TABLE 8. BATTERY CABLE REQUIREMENTS FOR 12-VOLT ELECTRIC GENERATING PLANTS (MAX. LENGTH OF ONE CABLE)

CABLE SIZE	2	1	0	00	000	0000
MAJ	7 ft.	9 ft.	10 ft.	14 ft.	17 ft.	20 ft.
MJC MDJB, MDJC MCCK, MDJA MDJE, MDJF	4 ft.	5 ft.	7 ft.	9 ft.	11 ft.	14 ft.

trical equipment or accessories to electric plant starting batteries.

GROUNDING

Install the electric plant batteries with negative ground polarity. Most propulsion engine batteries and vessel electrical equipment use a negative battery grounding system. Incorrect grounding can cause electrolysis and eventual destruction of valuable components. On some models, control box wires can be reversed to change the ground connection. Before attempting to reverse ground connections, read the plant instruction manual to avoid trouble.

To assure good ground contact between the electric plant and main engine, install a heavy jumper cable between the main engine ground and electric plant frame. If the ground of an electric starting plant is reversed, be sure to start it electrically the first time so the generator can adjust its polarity.

This means that if the boat is a positive ground and an MAJ plant is installed (MAJ only), start the plant electrically so the generator may polarize itself. Other units are negative ground only. Do not rope-start the plant on initial installation.

LOAD WIRING AND CONTROLS

LOAD WIRING

All wiring should meet the Coast Guard, NFPA and any other applicable codes. Have a qualified electrician install and inspect the boat wiring. The Onan wiring diagram does not include components that customers add. When installing the wiring to the generating plant, use a section of flexible cable next to the plant to absorb vibration. Many installers use flexible multistrand wire throughout the boat to reduce the danger of breakage from vibration. Onan recommends the installation of a line circuit breaker or fuses in the generator output circuit to protect the generating plant.

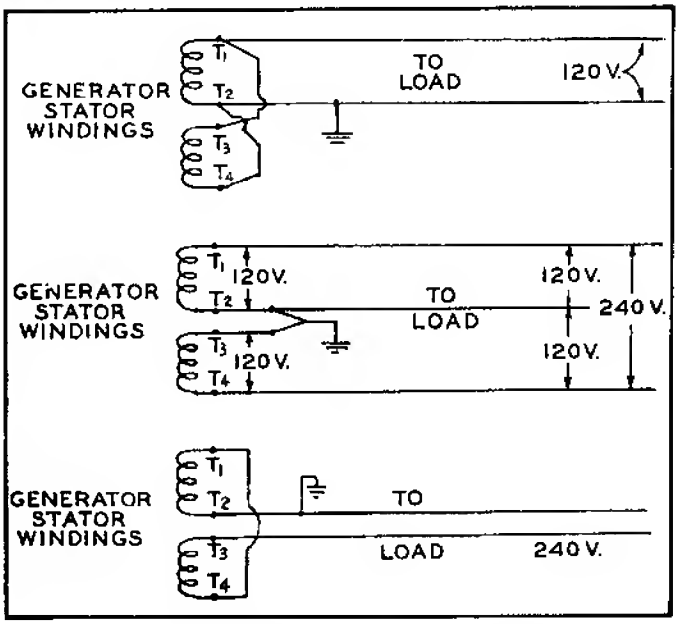


FIGURE 25. GENERATOR WINDING DIAGRAM

Some special precautions must be taken when installing AC load wires to *Onan* electric plants. If the plant is single phase, but has three output wires (120/240-volt output), the 120-volt load must be balanced between the two legs of the generator windings. This means connecting about half of the boat's 120-volt load to each leg of the generator output. Attempting to take the full load off only one leg could damage the generator output windings. Connect any 240-volt load across both windings.

Some single phase Onan electric plants are designated as reconnectible. They can be recognized by four output wires, and have two completely-separate 120-volt windings. These plants can be reconnected for either 120 volts, 240 volts or 120/240 volts (Fig. 26). When the generator is connected on 120/240-volt operation, be sure the 120-volt load is divided between the two legs.

Most boats incorporate a dockside connection so the boat can be plugged directly into a commercial source while at dock. If this is done, include a switch in the electric plant output to switch the load between the plant and dock power. The generator and power line source must never be connected. Either a manual switch (Figure 26) or the Onan marine load transfer control can be used for this function.

MARINE LOAD TRANSFER CONTROL

The marine load transfer control (Fig. 29 and 30) automatically switches the boat electrical load between the electric plant and shore power. When an operator plugs shore power into the boat, the control connects it to the load. When the operator pulls out the shore power plug, the line transfer automatically connects the electric plant and

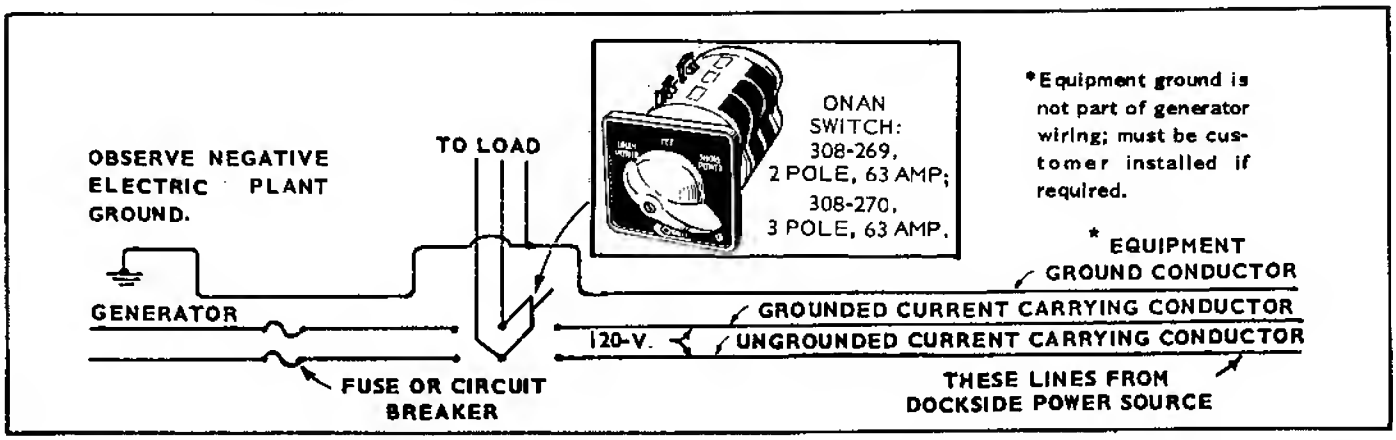


FIGURE 26. TYPICAL LOAD TRANSFER SWITCH DIAGRAM

load. This control won't start the electric plant, and won't connect the electric plant to the load when shore power is connected. When installing a marine load transfer control, locate it near the main power distribution panel and mount it to a firm bulkhead. Use cable of suitable size for the boat's load from the load transfer control to the shore power connection, electric plant and load. Follow wiring instructions furnished with the control.

STARTING CONTROLS

Standard remote start-stop controls for Onan remote starting electric plants (designated by an R in the model number) consist of a single-pole double-throw momentary contact switch connected by 3 wires to the plant remote control terminal block. Pushing the switch up starts the plant, pushing it down stops the plant.

NOTE: *Plants designated E in the model number are electric starting, but must be started at the plant control box.*

To control the electric plant from several locations, install separate switches and wire them in parallel (Fig. 27). Any number of switches may be used. Wire them with #18 wire for runs up to 75' between the switch and plant, and consult the plant instruction manual for longer runs.

For diesel engine-powered electric plants, connect an additional single-pole single-throw momentary contact switch for the engine preheat system.

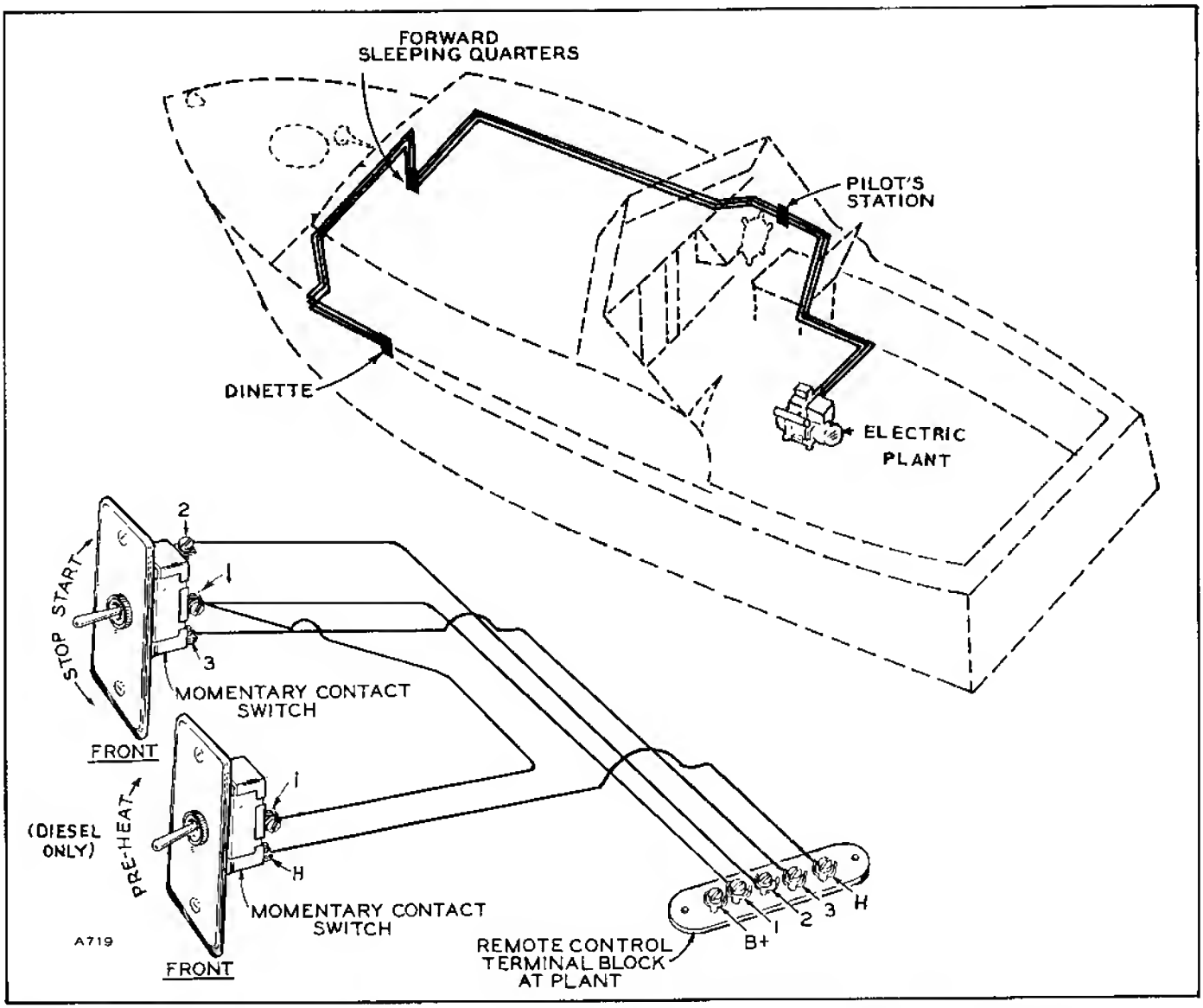


FIGURE 27. TYPICAL REMOTE STARTING SWITCH DIAGRAM

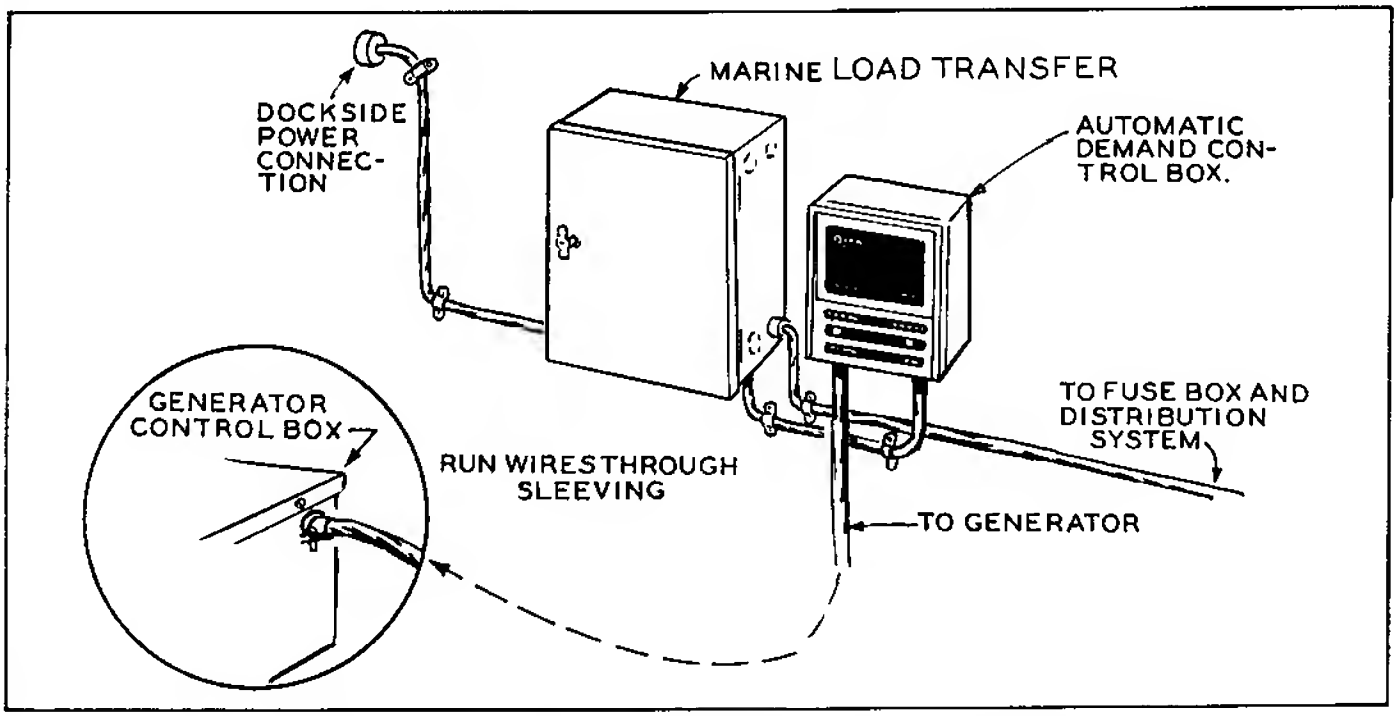


FIGURE 28. TYPICAL AUTOMATIC DEMAND AND LOAD TRANSFER

AUTOMATIC DEMAND CONTROLS

Automatic Demand Controls automatically start the electric plant if a load is switched on anywhere in the boat, and stop the plant when all loads are switched off. When installing an automatic demand control, be sure it is wired directly to the electric plant output (Figure 29). A modification is available for mounting the HA automatic load demand control directly on the MCCK generating plant. Current MCCK models have an automatic demand control mounted as standard (Control-O-Matic). The HA demand control must be used with negative ground battery systems only. Two terminals (late models) are supplied enabling the operator to utilize a remote control and overide the automatic control. A switch for dockside power or marine load transfer can then be wired to the demand control output.

If a permanent battery charger is to be used with a plant and demand-type control, special precautions must be taken. The battery charger, if installed on the output of the demand control, would present a continuous load and therefore cause the plant to run continuously. To eliminate this, install the battery charger in the electric plant output before the automatic control so it operates only when the plant is running. In most cases, this will keep the battery at full charge. A separate switch must then be installed to switch the battery charger to shore power.

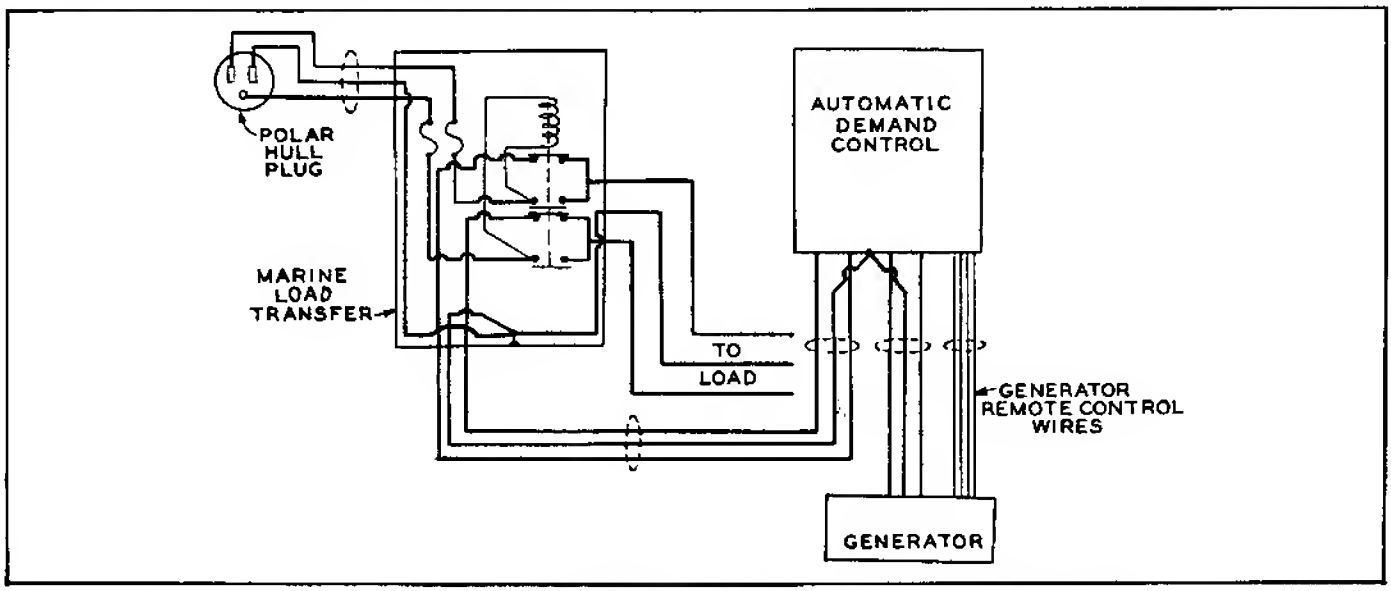


FIGURE 29. TYPICAL AUTOMATIC DEMAND AND LOAD TRANSFER DIAGRAM

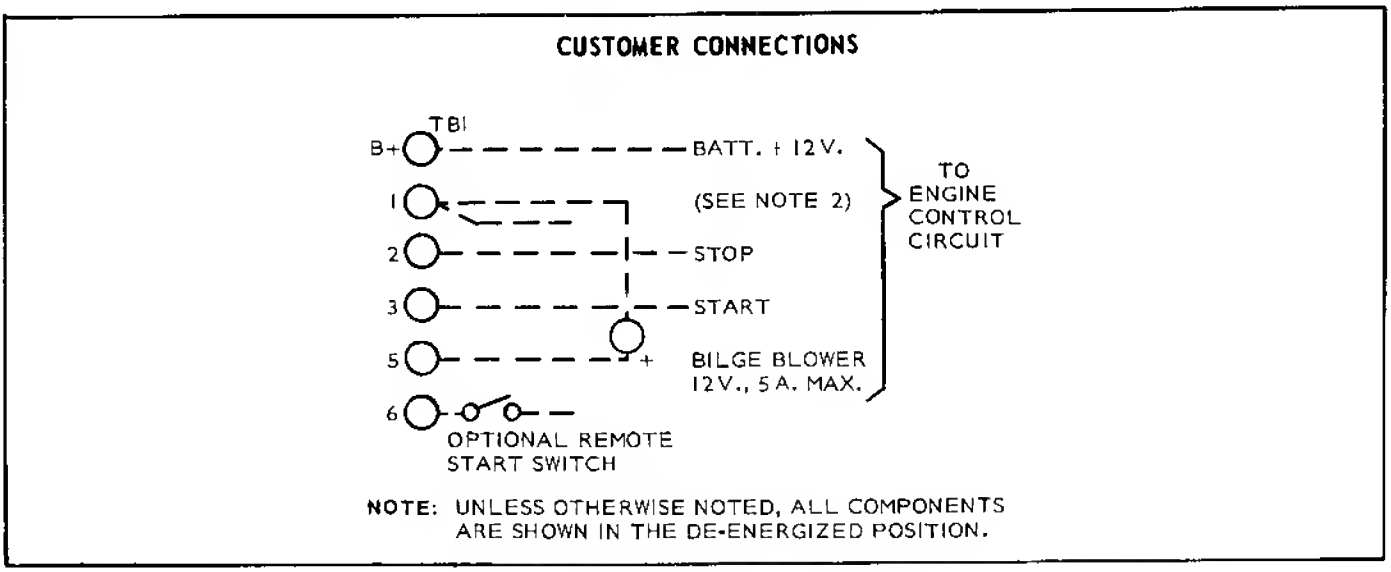


FIGURE 30. REMOTE TERMINAL CONNECTIONS

SUGGESTIONS FOR QUIETER OPERATION

Two types of noise are generally encountered with an electric plant installation; airborne noise and hull noise.

The most obvious airborne noise is generally exhaust. If objectionable, this can best be reduced by

1. Using an Aqualift muffler.
2. Using flexible exhaust line after the cooling water is injected, or adding a flexible section of line near the exhaust outlet.
3. Installing an exhaust deflector on the exhaust outlet to deflect exhaust toward the water.

With the exhaust silenced, other airborne noises might become evident. These can be caused by noise bouncing off large surfaces in the plant compartment. This can be reduced considerably by lining the compartment with sound absorbent material, such as fiberglass insulation Onan #128P90 for 2" or #128P91 for 1", especially the compartment ceiling and bulkheads adjoining living quarters. Seal all openings, cracks and joints in the bulkhead between the plant and living quarters. To prevent noise, wiring and pipes must be securely mounted and not vibrate against the vessel structure. Intake noise can be greatly reduced by installing an air intake resonator kit (includes flame arrester for gasoline plants) which is available from Onan for many early model electric plants.

For maximum noise reduction on Onan 6.0MDJB, 7.5MDJE, 12.0MDJC and 15.0MDJF plants, install the Onan "Sound Shield" which is an insulated fiberglass enclosure which completely surrounds the electric plant (Figure 31). Openings are provided for connection to all external lines and wires. Internal air ducts reduce airborne noise to a minimum. Contact your local Onan dealer for noise reduction methods and the special kits which are available.

The rubber damper mounts supplied with Onan electric plants reduce hull vibrations to a minimum and the use of flexible water, exhaust, fuel and electrical connections to the plant further reduces them. As a check of the flexibility of connections, shake the plant from side to side and end to end. It should rock freely, without hitting anything. At the same time, check to be sure the plant is securely mounted and the mount is rigid. As a final check, be sure all auxiliary equipment in the compartment is rigidly mounted. Even one loose component could amplify any vibration.

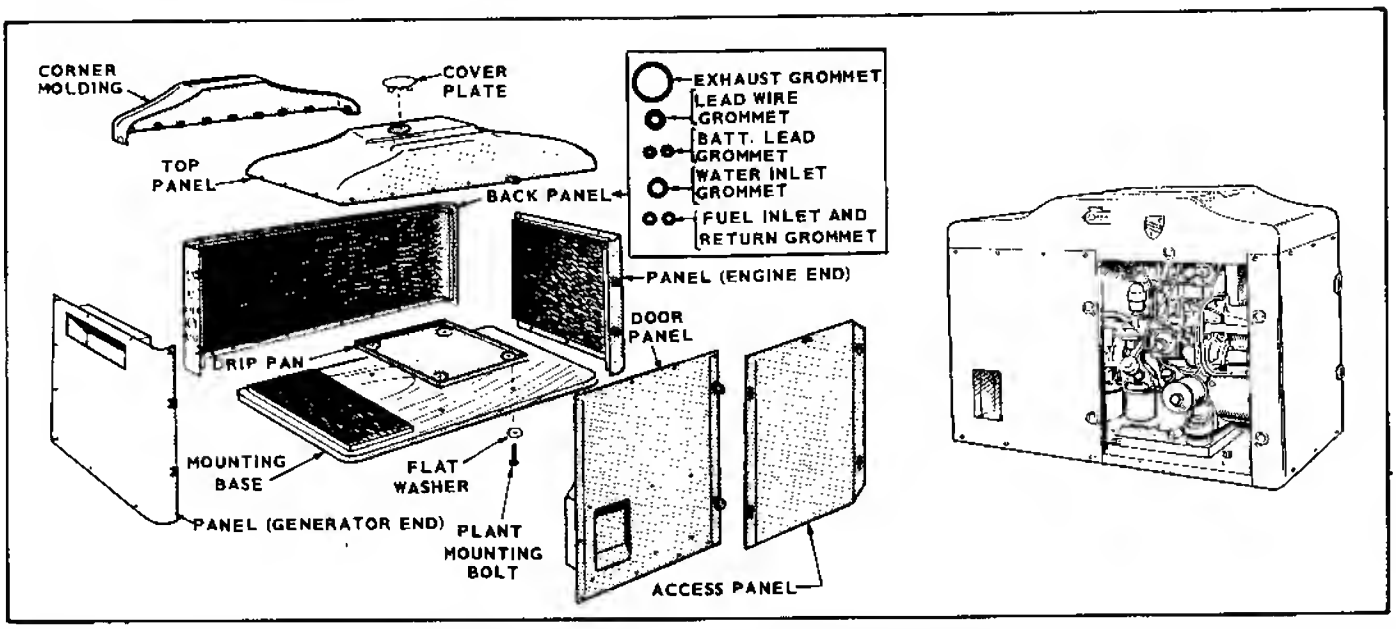
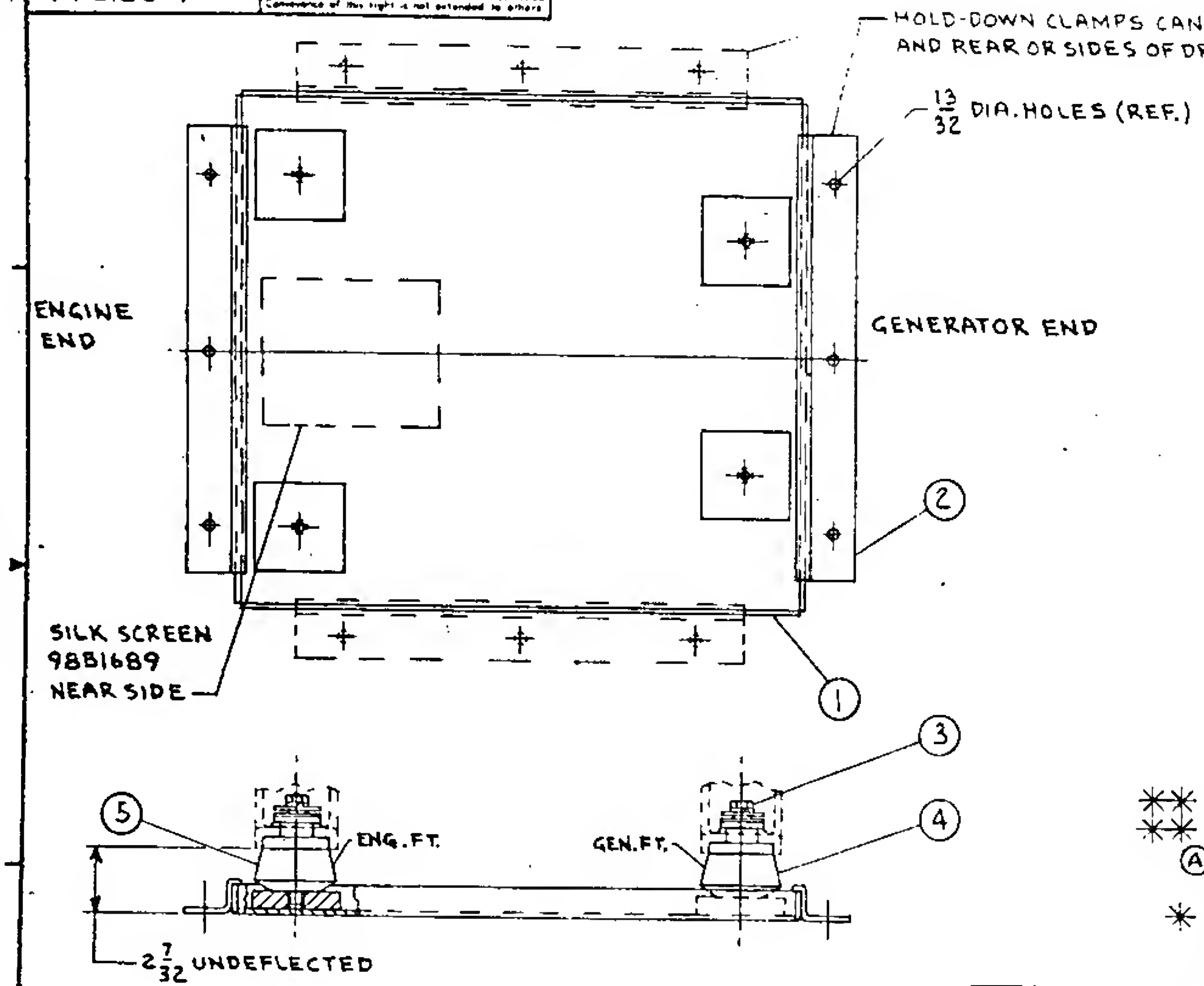


FIGURE 31. CUTAWAY OF ONAN "SOUND SHIELD"

179B204[M]



	ITEM	PART Nº	QTY	DESCRIPTION
	6	M73	1	INSTRUCTION SHEET
**	5	402B283	2	CUSHION MARK "ENGINE"
**	4	402B285	2	CUSHION MARK "GEN."
(A)	3	402B360	4	HARDWARE · MTG.
	2	405B1265	2	CLAMP - HOLD DOWN
*	1	405C1554	1	DRIP PAN ASSY.

LIST OF MATERIAL

* ITEM Nº 1 SILK SCREEN PER 98B1689 AFTER FINISH PAINT

** ITEMS 4 & 5 MARK BY SHIPPING ("GEN." OR "ENGINE")

LTR	REVISIONS	ZONE	ENG	CKR	DATE
A	WAS #402 B 232	C3			12-7-65

NEXT ASSEMBLY: 179B205

SIMILAR TO: 179B175

TOLERANCES UNLESS OTHERWISE SPECIFIED — FRACTIONS / DECIMALS / ANGLES

MATERIAL: SEE LIST OF MATERIAL

MODEL: 605MCCK

Onan — DIVISION OF STUDEBAKER INDUSTRIES INC, Minneapolis, Minnesota

DATE: 1-26-65 | DR: AHO | CKR: DMT | SCALE: 1/4=1

NAME: ILLUSTRATION - DRIP PAN MTG.

DWG NO: 179B204[M]

179B204

FORM 8A871

Onan
DIVISION OF STUDEBAKER CORPORATION
MINNEAPOLIS, MINNESOTA 55432
Printed U.S.A.

INSTRUCTION SHEET M69e

CONE MOUNT INSTALLATION

GENERAL

Mounts, cushions, vibration isolators or dampers are synonymous names. The mounting floor or base should be flat and give support directly under the plant mounting feet. In a marine installation using a drip pan, the mounting floor must support the entire drip pan. Allow a minimum of 2-1/2 inches clearance on all sides of the plant for freedom to rock. Use flexible exhaust line, fuel line, battery cables, and electrical wiring to prevent breakage and to allow plant movement. None of the attaching lines should be pulled tight when the plant is rocked to its mounting limits.

The plant should deflect (compress the cushion) approximately 3/16 inch. These cushions are all the same size but a different part number has a different hardness. The correct cushion is important.

INSTALLATION

See the parts list and illustrations for correct installation. The parts list shows the differences in hardware and cushions according to the particular model and installation. For new plants use the template supplied in the Master Packing List.

1. Secure the cushions marked with a lower part number under the engine mounting (lighter end of plant); use the correct length of 7/16 inch diameter screw and other hardware (see parts list and illustration).
2. Secure the cushions marked with a higher part number under the generator mounting (heavier end of plant); use the correct length of 7/16 inch diameter screw and other hardware (see parts list and illustration).
3. Secure and tighten the cushions and hardware to the mounting floor. Measure approximately 1/16 inch clearance between the flat washer and snubber (see illustration). Add flat washers (item 6A), if necessary, to obtain clearance. Check for 1/2 inch clearance between protruding bolt end and engine parts (avoids puncturing oil filter).
4. For marine and other installations using a drip pan, install holddown clamps at both ends of both sides of the drip pan. For Vacu-Flo models, the separate supports (rails) must be properly positioned and bolted to the mounting floor (supports provide clearance below the air-discharge scroll).

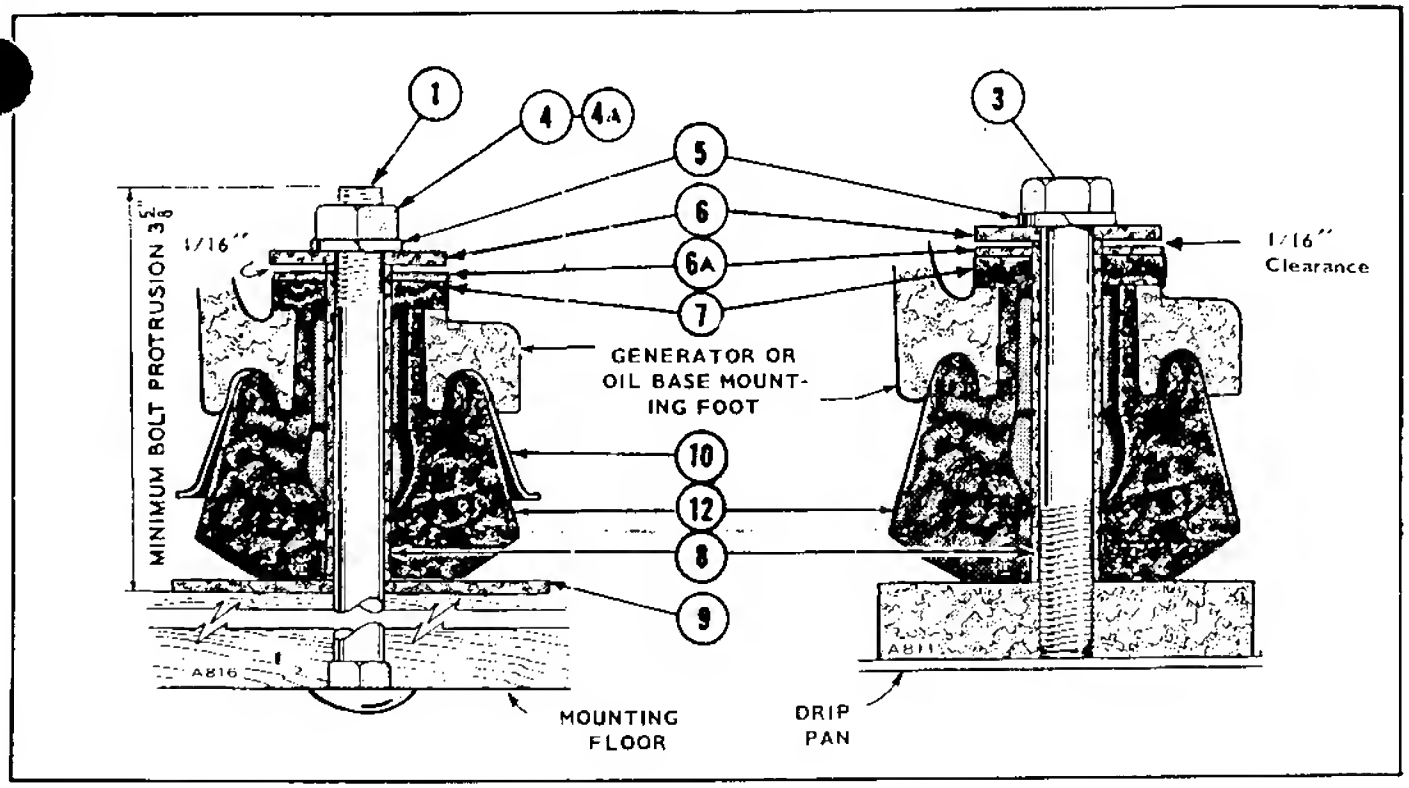
TABLE OF CUSHION LOCATION (2 EACH PER PLANT)

MODEL	ENGINE CUSHION	GEN. ★ CUSHION	NOTES
LK	402B283	402B283	D
JA	402B283	402B284	
JB	402B284	402B286	A,B
JB	402B284	402B285	A,C
JC	402B284	402B287	A
4MCCK	402B283	402B284	
DJA	402B284	402B285	
CCKB, DJB	402B284	402B285	
DJC	402B285	402B287	
CCK	402B283	402B285	D
MJA	402B283	402B284	
5MJB	402B284	402B286	
705MJB	402B284	402B285	
MJC	402B285	402B287	
605MCCK	402B283	402B285	
MDJA	402B284	402B285	
MDJB	402B284	402B285	
MDJE	402B284	402B285	
MDJC	402B285	402B287	
MDJF	402B285	402B287	

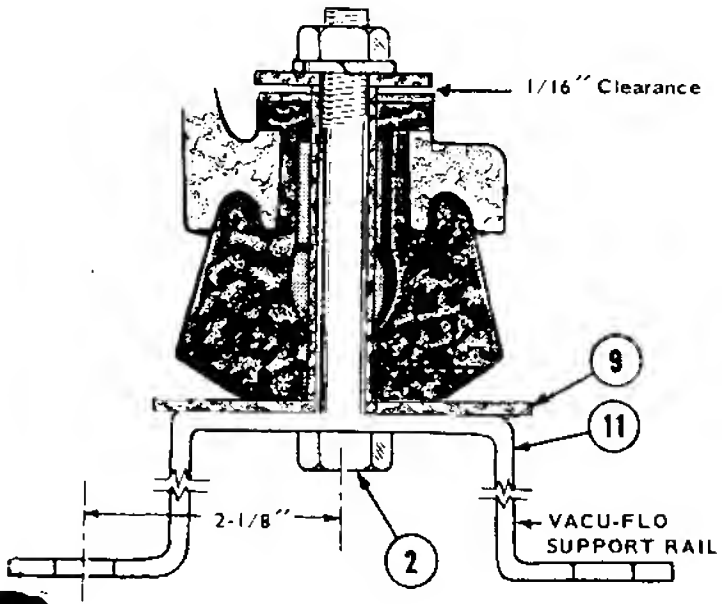
Generator end is heavier - use heavier cushions

NOTES

★ - Always use higher part number cushion for generator support.
A - Includes Vacu-Flo Cooled Models.
B - Revolving-armature generator.
C - Revolving-field (with static exciter) generator.
D - Mobile Units Only.



NOTE: Mounting cushions as furnished by factory in sets of four, have their part numbers imbedded in the cushion. Two of the cushions will have higher numbers and will be firmer in feel. Mount these two under generator end of unit. The softer cushions with the lower numbers are to be mounted under engine end of unit.

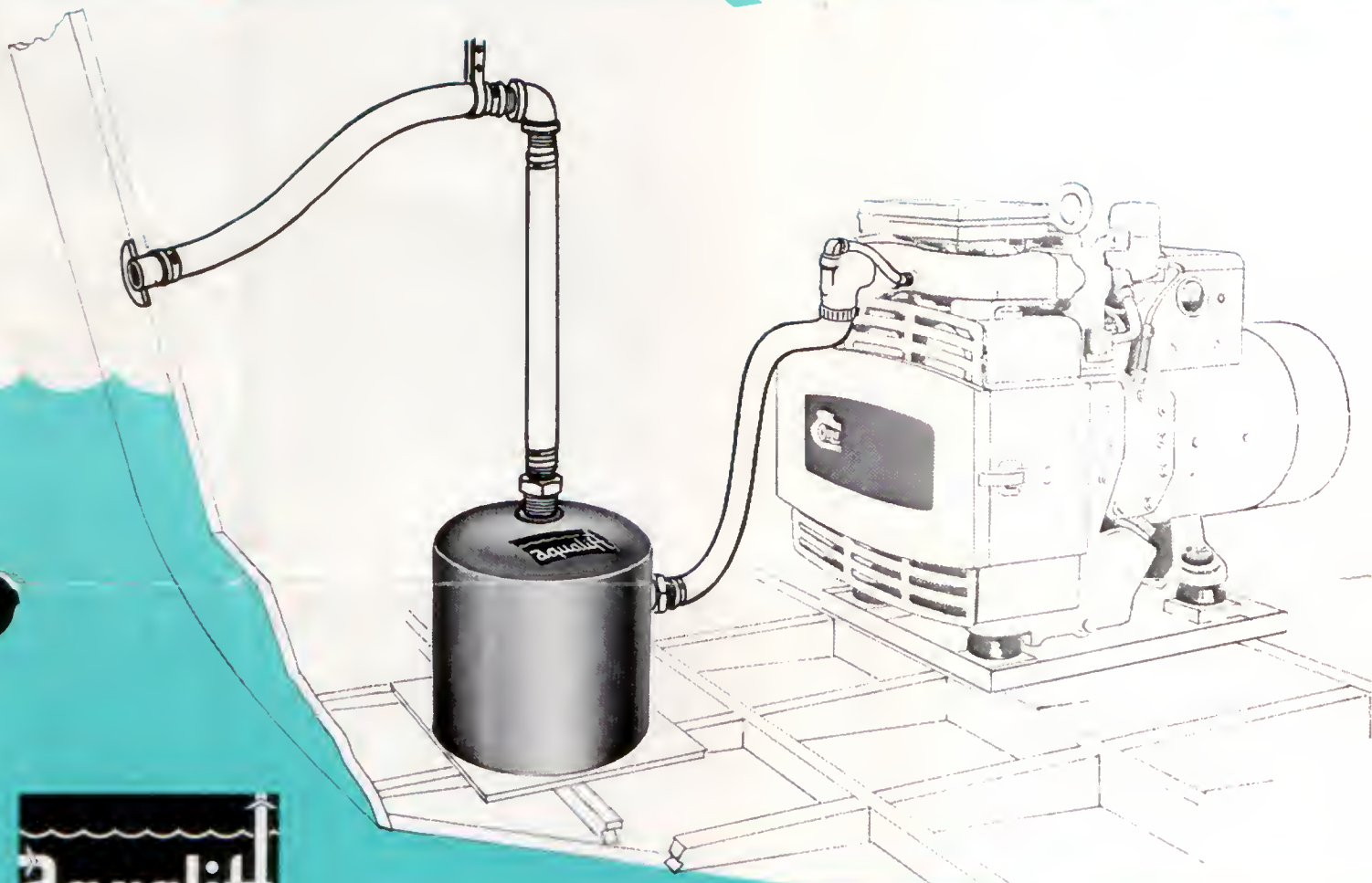


REF. NO.	PART NO.	PART DESCRIPTION
1	816-212	Bolt, Carriage (7/16-14 x 5-1/2") JA, JB, JC, DJA, DJB, DJC.
2	800-82	Capscrew, Hex Hd. (7/16-14 x 3-3/4") Vacu-Flo JB, JC, LK Mobile, CCK Mobile
3	800-81	Capscrew, Hex Hd. (7/16-14 x 3-1/2") MJA, MJB, MJC, MDJA, MDJB, MDJC, MCCK, MDJE, MDJF
4	862-4	Nut, Hex Hd. (7/16-14)
5	850-55	Washer, Lock (7/16 Med.)
6	526-14	Washer, Flat (1-1/2 x 29/64 x 1/8)
6A	526-198	Washer, Flat (1-1/2 x 5/8 x 1/16) - Use as required to maintain proper clearance.
7	402A282	Snubber
8	402A290	Bushing, JB, DJB, MJB, MDJB, JC, DJC, MJC, MDJC, MCCK, MDJE, MDJF, LK Mobile, CCK Mobile
	402A328	Bushing, DJA, MDJA
9	526A195	Washer, Flat (3-1/4 x 29/64 x 1/8) - Not used in drip pan installation.
9A	526A199	Washer (Notched) R.R. Gen. End - Housed Units Only.
10	402A300	Cup, Cushion Retaining - MDJA
11	403B710	Support, Vacu-Flo - JB, JC
12	See Table	Cushion, (Table listing is subject to change. Do not order parts from Table.)

Marine Onan®

A UNIQUE DUAL-PURPOSE MARINE ELECTRIC PLANT MUFFLER

ONAN AQUALIFT®

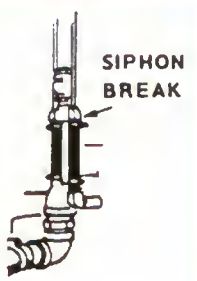


Aqualift MUFFLER®

PERFORMS TWO IMPORTANT FUNCTIONS IN ONE OPERATION

1. **AquaLift silences** exhaust noises more effectively with proportionately less back pressure than any muffler yet developed.

2. **AquaLift lifts** engine cooling water up to four feet without the aid of a pump, for convenient discharge above the water line.



Siphon break required below water line.

NOW ENJOY YOUR ELECTRIC CONVENIENCES EVEN MORE

DUAL PURPOSE DESIGN – AquaLift represents a practical, new approach to marine muffler and exhaust system design. Through unique interaction of the cooling liquid and exhaust gases, AquaLift actually performs two functions in one operation. While the liquid cools the hot gases and effectively swallows-up exhaust noises, the kinetic energy of the gas carries the liquid upward for convenient discharge above the water line.

U.S. Patent No. 3296997

MAXIMUM MUFFLING CAPACITY – Regardless of whether the plant is installed above or below the water line, AquaLift offers unmatched muffling capacity at all engine speeds. A variable discharge orifice in the muffler automatically adjusts to engine load, smoothing out combustion pulsations and maintaining maximum silencing capacity under all load conditions.

ELIMINATES WATER PUMP AND RISERS – Capable of lifting the cooling liquid up to four feet without the aid of a pump or other moving parts, AquaLift eliminates the need for bulky water jacketed risers on below-water-line* installations. While conventional exhaust systems with water-jacketed risers require rigid mounting allowing noise and vibration to be transmitted to the hull, AquaLift permits resilient mounting and flexible, vibration-free hoses and connections, contributing to the overall smooth operation of the plant. **Siphon break required below water line.*

RESISTS RUST AND CORROSION – A heavy coating of tough, durable Co-Polymer applied by the roto-cast method permanently protects AquaLift against rust and salt water corrosion.

EASY TO INSTALL – AquaLift is compactly designed for easy installation with any make or model marine electric plant with maximum exhaust pressure not exceeding 3 inch mercury column. It is suitable for use on all types pleasure craft, utility and workboats.

DIMENSIONS AND WEIGHT – Diameter: 12″; Height: 12″; Pipe fittings: 1″, 1¼″ or 1½″; Weight: 17 pounds.

Be sure to order pipe fitting packages in addition to muffler.

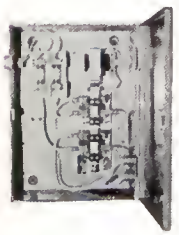
MUFFLER	PIPE FITTINGS		FITS ONAN MODELS
155K1004	1½ inch	155A954	MJC, MDJC, MDJF
	1¼ inch	155A955	MDJA, MDJB, MDJE, MCCK
	1 inch	155A956	MAJ

NOTE:

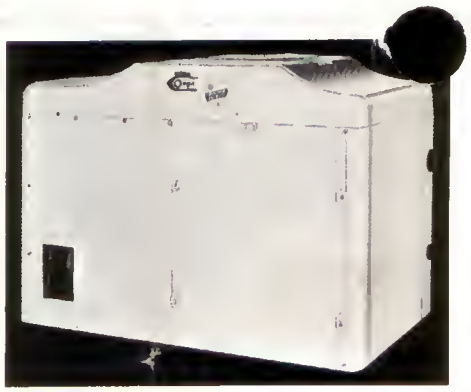
An approved type of hull strainer is furnished with each muffler and must be used to eliminate either back pressure or a vacuum as created by other style of strainers.

LOOK TO ONAN FOR THE FINEST IN MARINE ELECTRIC GENERATING EQUIPMENT AND ACCESSORIES

MARINE ELECTRIC PLANTS – Feature for feature . . . model for model . . . dollar for dollar . . . you can't buy a better marine electric plant than Onan. Available from 2500 to 50,000 watts AC. Battery charging models from 600 to 2500 watts DC. Gasoline or diesel.



ELECTRIC PLANT CONTROLS – Add to your boating pleasure with Onan Automatic Start-Stop Controls and Shore Line Transfer Controls, built by Onan to match Onan Marine Electric Plants.



SOUND SHIELD ENCLOSURE—Enjoy super-silent marine electric power with Onan's exclusive new Sound Shield enclosure. Available with Onan 6000, 7500, 12,000 and 15,000 watt diesel marine plants.

For more information on all Onan Marine Products, call your Onan distributor or write the factory for Marine Catalog F-106.

ONAN 1400 73RD AVENUE N.E.
MINNEAPOLIS, MINN. 55432
A DIVISION OF STUDEBAKER CORPORATION

Litho in U.S.A. F-235-D

Marine Onan®

— GEN —

OUTPUT LEAD(S);

CAUTION !

IF GEN IS CONNECTED TO LOAD TERMINALS, THE AC OUTPUT VOLTAGE WILL DESTROY THE LOAD SENSOR AMPLIFIER.

— LOAD —